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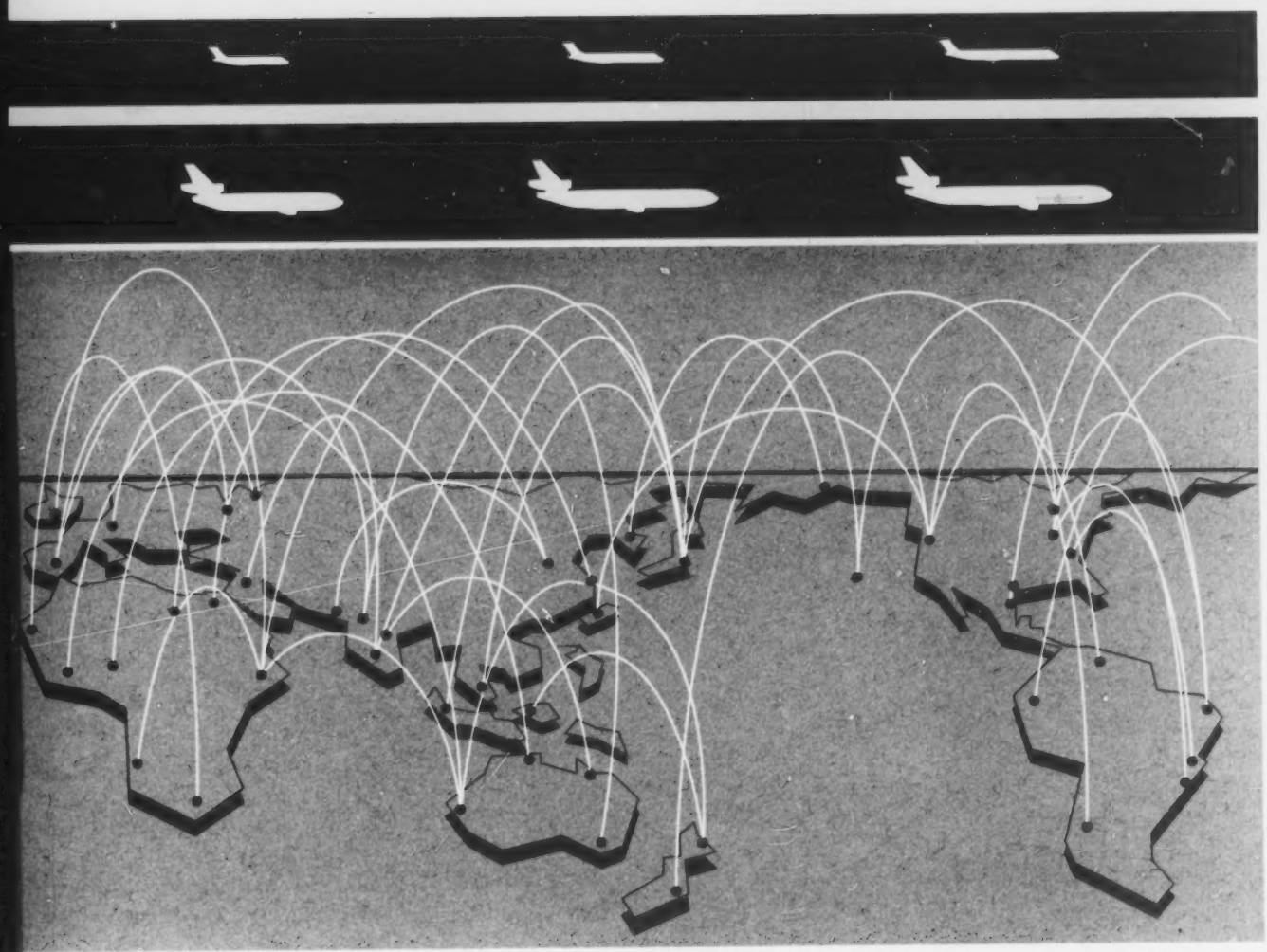
# 1991-2010



# *Outlook*
## for
# COMMERCIAL AIRCRAFT

MCDONNELL DOUGLAS

*1991-2010*

# *Outlook*
# *FOR COMMERCIAL AIRCRAFT*

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# Introduction

# *Overview*

The *Outlook for Commercial Aircraft 1991-2010* is a 20-year forecast of the equipment needs of the commercial aviation industry. Douglas Aircraft Company, a component of the McDonnell Douglas Corporation, prepares this outlook for its internal planning. We hope that our customers, suppliers/partners, industry analysts, and others will also find this report useful in assessing the future of our industry.

This year's *Outlook* begins with an Executive Summary, presenting the number of aircraft forecast to be delivered between 1991 and 2010. This section presents delivery data split between wide-body and narrow-body aircraft and across regions. This information is expressed in both airplane units and U.S. dollar values.

The next section, World Environment for Airlines, summarizes the McDonnell Douglas forecast of the world economy. (A detailed forecast of the economy as well as energy and traffic is available in the companion McDonnell Douglas publication, *World Economic and Traffic Outlook, An Analysis of World Economies and Passenger and Cargo Forecasts, 1990-2010.*) Following the economic forecast is a brief discussion of the outlook for the price of jet fuel and for airline passenger yield, the average revenue received per passenger-kilometer. Next is a short segment, Airline Industry Trends. The section concludes with the passenger traffic forecast, a key input in forecasting aircraft requirements. RPK (revenue passenger-kilometer) information is shown for major routes, such as the North and Mid-Pacific, and for the five regional airline domiciles, North America, Europe, Pacific/Asia, Middle East/Africa, and Latin America.

The Passenger Fleet Requirements section discusses some of the assumptions and methods employed in forecasting aircraft requirements. Included are passenger load factor, available seat-kilometers (ASKs), and definitions of the 10 McDonnell Douglas generic passenger aircraft classes. This section continues with a forecast of the world aircraft fleet, including regional and aircraft-class detail. The aircraft retirement forecast is shown, and the new McDonnell Douglas Aircraft Retirement Model is discussed. The Passenger Fleet Requirements section includes the most important parts of this report — the forecast of aircraft delivery requirements, existing firm airplane orders, and the projected size of the open market for commercial jets. For each of these three key variables, the outlook is reported by generic aircraft class and by the five regional airline domiciles.

The fleet, delivery, order, and open-market data presented in this report have been derived using McDonnell Douglas' data base of world airlines. The "McDonnell Douglas world fleet" comprises 218 airlines and accounts for 98 percent of total world ASKs, excluding U.S.S.R. domestic capacity.

The Cargo Fleet Forecast section begins with a description of recent trends in the cargo industry. Cargo traffic is then presented, detailed by scheduled freight, mail, and nonscheduled freight. Next are the definitions of the 3 generic freighter aircraft classes. Finally, the size of the required freighter fleet is shown. This information is presented in annual detail for the 3 generic classes of dedicated freighter aircraft.

Existing and planned aircraft models in each class are listed in the appendix and detailed forecasts of key variables are presented.

# *What's New*

This edition of *Outlook for Commercial Aircraft* incorporates several changes from the last McDonnell Douglas publication on this topic (February 1989).

- The length of the forecast period has increased from 15 to 20 years.
- Increased regional detail is provided for passenger aircraft.
- The definitions of the generic classes have been modified to fit today's trends in aircraft sizes.
- Aircraft retirements have been forecast using a simulation model consistent with U.S. regulations and European guidelines regarding older jets.
- Departure growth rates have been forecast using econometric models.

Please address any comments, suggestions, or questions regarding the material presented in this book to Douglas Aircraft Company, Market Assessment (7-82), 3855 Lakewood Boulevard, Long Beach, California 90846-0001, USA.

# *Executive Summary*

# *Passenger Aircraft Market*

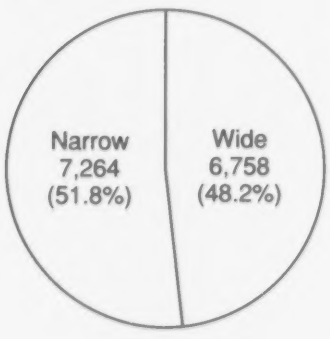
During the next 20 years, over 14,000 passenger jet aircraft are forecast to be delivered into the world's airline fleets. These planes are split almost evenly between wide-body and narrow-body units. When converted to dollars, the picture is different: wide-bodies account for nearly 75 percent of delivery value. In constant 1990 dollars, the value of the jets to be delivered in the next two decades is nearly a trillion (a million million) dollars.

What airlines will need these new jetliners over the next two decades? The worldwide distribution of deliveries parallels closely the forecast growth in air traffic. The following regional detail is based on airline domicile.

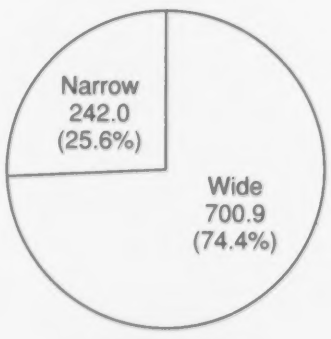
- In the number of airplane units to be delivered, North America dominates with 40 percent of the world total. Europe and Pacific/Asia are almost equal with nearly 25 percent each.
- Pacific/Asia is expected to take delivery of the largest number of wide-body aircraft with 2,395 units, comprising almost 75 percent of all deliveries to that region.
- In narrow-body units, North America accounts for nearly half of total world deliveries, with 3,465 units.
- Measured by the number of constant 1990 dollars to be spent on new airplanes, North America and Pacific/Asia are virtually identical at slightly more than $300 billion apiece, accounting for two-thirds of all dollars spent.
- In value of wide-body aircraft, Pacific/Asia leads the world, with over $280 billion to be spent. This is nearly 40 percent more than the next largest region, North America. Over 90 percent of Pacific/Asia's expenditures on new aircraft will be on wide-bodies.

## *World Passenger Aircraft Deliveries*

***By Fuselage Type, 1991-2010***




14,022 Units




$942.9 Billion
(Constant 1990 Dollars)

Excludes U.S.S.R.

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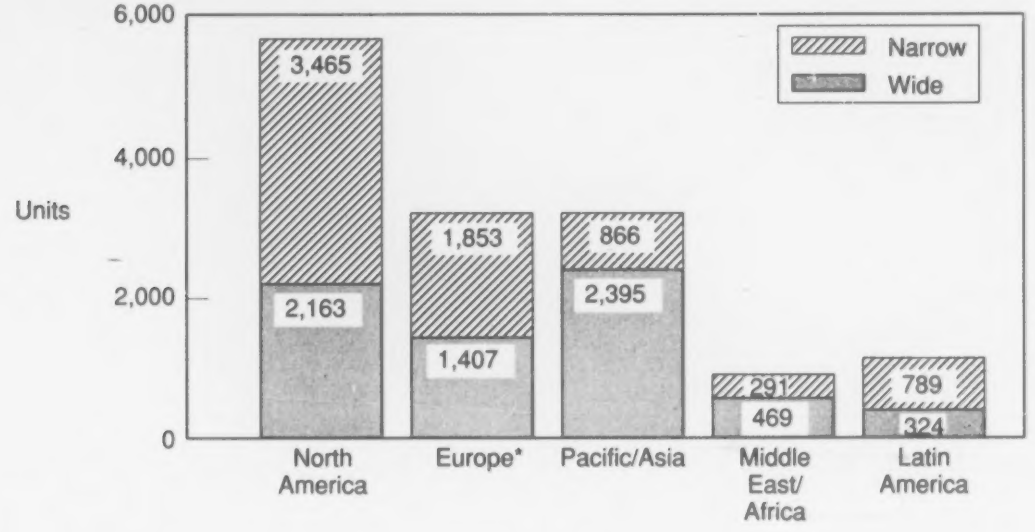
## *Passenger Aircraft Delivery Units*

***By Domiciled Region, 1991-2010***

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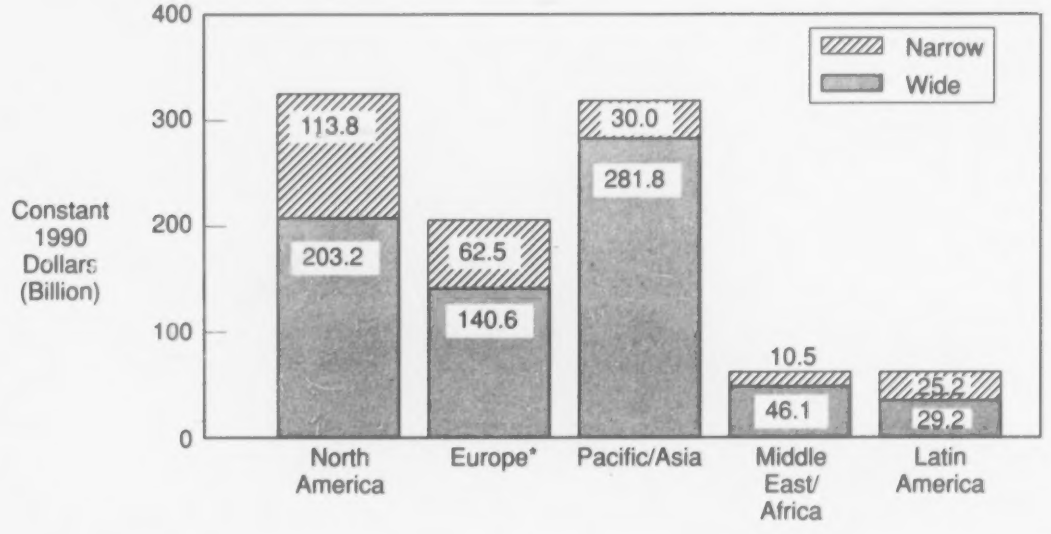
## *Passenger Aircraft Delivery Value*

***By Domiciled Region, 1991-2010***




*Excludes U.S.S.R.

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# *Cargo Aircraft Market*

According to the forecast, the world freighter fleet will nearly triple over the next 20 years, from 768 units in 1990 to 2,129 in 2010. The larger the freighter, the bigger the requirement for additional aircraft.

- The fleet of large freighters will expand at an annual average rate exceeding 11 percent per year. Many of these planes will serve routes involving Pacific/Asia.
- The medium freighter fleet will increase at an average annual rate of 6 percent over the next 20 years. These jets will be targeted for routes across the North Atlantic and similar distances.
- The number of small freighters will grow modestly at an annual average rate of 2 percent a year. These planes will serve mainly domestic and regional markets.

# World Environment for Airlines

# *Economy*

The key recent event in the world economy is the recession in the United States. This long-postponed downturn arrived in the second half of 1990, worsened by events associated with the conflict with Iraq. The recession has persisted through much of 1991. Its original causes include weak consumer demand, reduced government spending, and restrictive bank lending. McDonnell Douglas forecasts a somewhat modest recovery in 1992 for the United States and for North America as a whole.

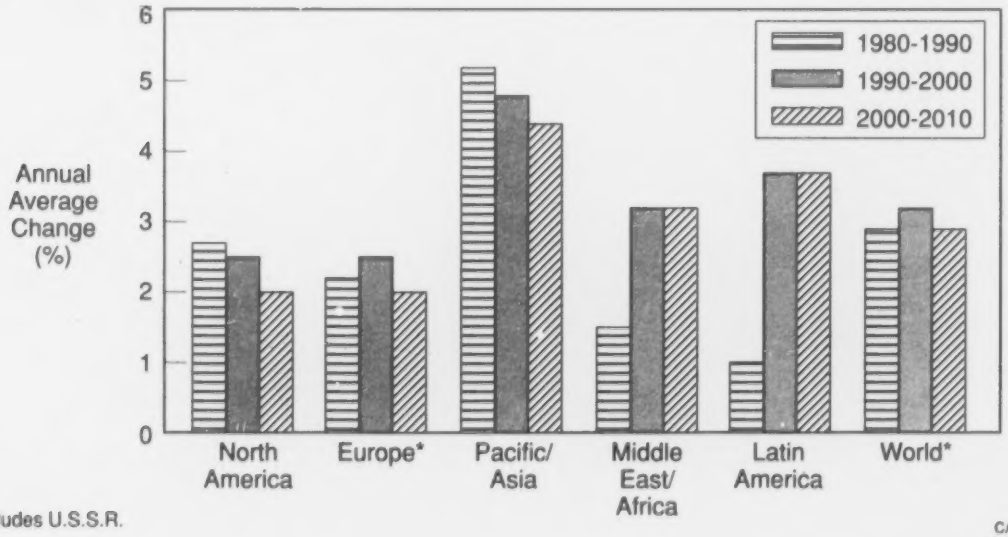
Other regions have also experienced an economic slowdown. Total world real growth is forecast to fall to about 1% in 1991. Slow growth in 1991 is predicted for Western Europe, Middle East/Africa, and Latin America. The economies of Eastern Europe are expected to have real declines in 1991. Even the booming region of Pacific/Asia is forecast to slow its expansion slightly in 1991.

McDonnell Douglas predicts an economic recovery for most areas in 1992. Pacific/Asia, Western Europe, Middle East/Africa, and Latin America are all expected to enjoy higher than usual growth levels in that year. By contrast, Eastern Europe is forecast to continue to contract in 1992, although at a slower rate than in 1991.

Real economic growth in North America is expected to be at an annual average rate of 2.6 percent from 1990 to 2000 and 2.1 percent from 2000 to the end of the forecast period, 2010. Because of the economic integration brought about by EC92, Western Europe is anticipated to enjoy higher economic growth in the next decade (2.6 percent on an annual average basis) than in the last (2.3 percent). But annual average growth there is forecast to slow to 2 percent between 2000 and 2010. Eastern Europe is not anticipated to show significant, real economic growth until after the end of this century. The major reason is its inability to adjust rapidly to a free-market economy.

## *Economic Growth*

***By Geographic Area, Real GDP***




*Excludes U.S.S.R.

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Pacific/Asia will continue to be the fastest growing region in the world. From 1990 to 2000, annual average real economic growth is predicted to be 4.8 percent in this geographical area. In the following decade, this rate is expected to fall slightly to 4.4 percent. The second-fastest-growing region is envisioned to be Latin America, largely because of the economic restructuring of the 1980s. McDonnell Douglas expects 3.7-percent annual average growth for both decades for Latin America. The long-term outlook for Middle East/Africa is considerably brighter, with real economic growth expected to exceed 3 percent per year.

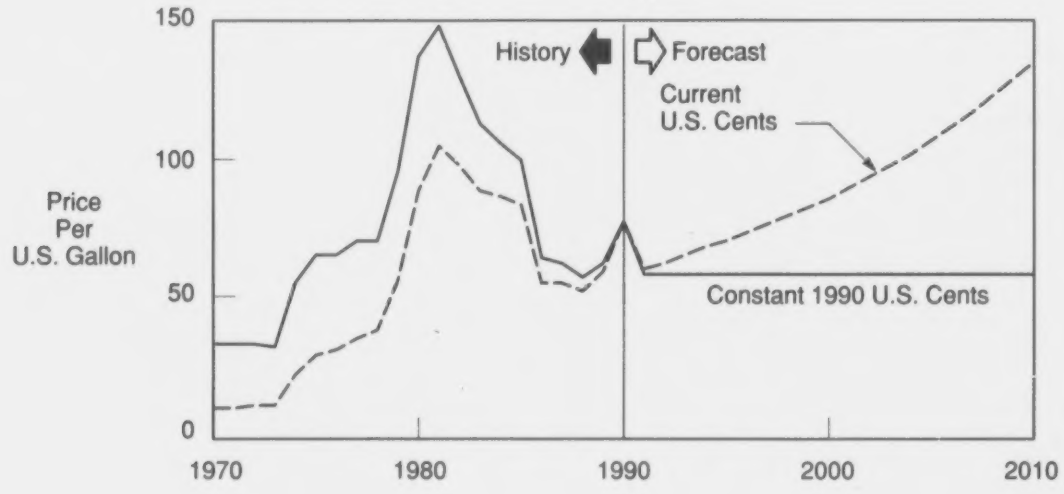
On the whole, the world economy will grow at an annual average rate of 3 percent for the next decade and 2.9 percent for the first 10 years of the next century, according to the McDonnell Douglas forecast. This level of expansion is very similar to that of the last decade but is well below the 3.6-percent level of the 1970-80 period. For planning purposes, economic slowdowns are forecast in 1995, 2001, and 2006. The timing of these "growth pauses" is approximate.

# *Jet Fuel*

The conflict with Iraq caused dramatic fluctuations in world energy markets in 1990 and 1991. For example, the U.S. price of jet kerosene in 1990 peaked at $1.39 per U.S. gallon in mid-October. The average price for that year rose 29 percent over the 1989 level to 78 U.S. cents. But the average 1991 U.S. price of jet fuel is forecast to drop to 61 cents, nearly the same level as in 1989 and actually 6.4 percent lower than the 1989 price when the effects of inflation are removed.

Beyond 1991, the energy outlook remains essentially the same as that forecast by McDonnell Douglas for several years: There will be no upward trend in either oil or jet kerosene prices over the next two decades once they are adjusted for inflation. But the short-term volatility of energy prices is expected to remain high, creating continued difficulties for airlines.

## *U.S. Jet Kerosene Price*

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# *Passenger Yield*

Airline passenger yield is the average revenue received per passenger-kilometer. In real terms (removing the effects of inflation), airline yields have declined nearly every year since the beginning of commercial aviation. This has occurred because airlines have passed on to their customers most of the cost savings that have resulted from technology advances, longer average trips, and economies of scale. This decline in real passenger yields has averaged 1.4 percent per year over the past two decades.

Consistent with its jet kerosene price forecast, McDonnell Douglas projects that real yields will continue to fall as airlines continue to become more efficient. In other words, yields will not rise as fast as inflation. But real yields are forecast to fall at a much slower rate, partly to allow airlines to regain a better rate of return for their investors. Worldwide real passenger revenue per RPK is predicted to diminish at an annual average rate of 0.7 percent through 2010.

## *World Passenger Yield Development*

***Annual Average Percent Change (Real Terms)***

| History | Average % Change |
|---|---|
| 1970-75 | +0.32 |
| 1975-80 | –1.27 |
| 1980-85 | –5.58 |
| 1985-90 | +1.00 |
| 1970-1990 | –1.42 |

| Forecast | Average % Change |
|---|---|
| 1990-95 | –0.87 |
| 1995-00 | –0.74 |
| 2000-05 | –0.59 |
| 2005-10 | –0.65 |
| 1990-2010 | –0.71 |

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# *Airline Industry Trends*

As of this writing, the airline industry continues to react to the economic downturn that began in 1990. The downturn, the conflict with Iraq, and the related spike in jet fuel price have devastated many carriers while affecting every last one. Despite these serious problems, the long-term future of commercial aviation remains very bright for both airlines and airplane manufacturers. The industry's greatest strength is its ability to bear the hard times, restructure, and benefit from the good times. With strong, long-term economic growth predicted, passenger and cargo traffic will soon grow at their traditional rates, with especially strong increases expected on routes touching Pacific/Asia. With the recent demise of less efficient carriers, the industry will soon strengthen, profits will rise, and investors will begin to see better returns from their airline stocks.

Carriers will require a large amount of new equipment to carry tomorrow's traffic, especially long-range wide-body airplanes. In addition, there is a strong need for narrow-bodies in this decade, to replace the aging, noisy 727s and early DC-9s and 737s as well as to accommodate increased air travel.

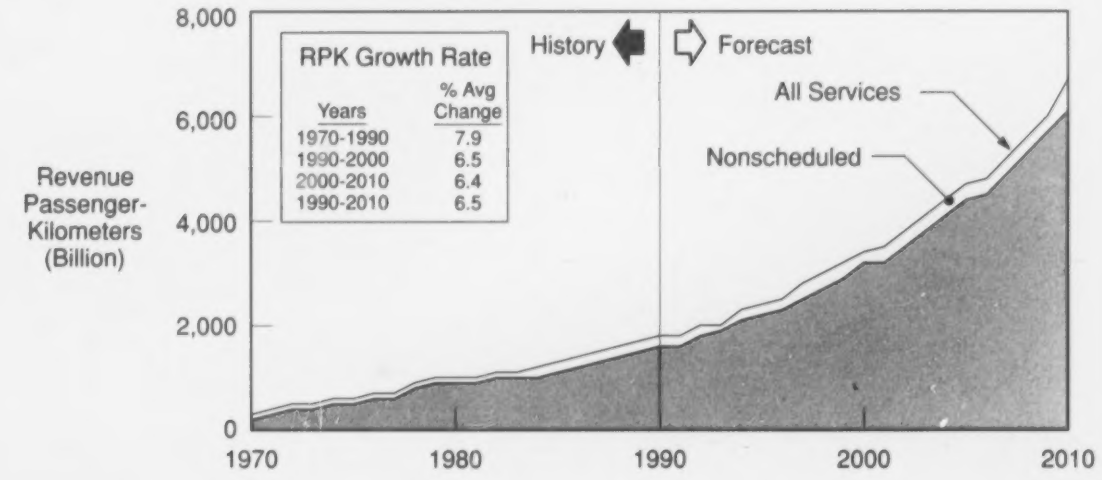
# *Passenger Traffic*

1991 is forecast to be one of the worst years in history in terms of the growth of scheduled passenger air traffic. Three factors combine to cause airlines such problems.

- The economic slowdown
- Passenger concerns over possible terrorism because of the conflict with Iraq
- Increases in airfares, required by rises in the price of jet kerosene

These three elements will cause worldwide, scheduled passenger traffic to remain relatively unchanged from 1990. On the North Atlantic, the largest international route, and within the U.S., the largest area for domestic traffic, 1991 RPKs are forecast to decline from 1990 levels.

## *World Passenger Traffic, All Services*




Excludes U.S.S.R.

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In the long term, the picture is much brighter. The rebound of the world's economies will cause passenger traffic to increase as it has historically, at about twice the economic growth rate. RPK growth is forecast to average 6.5 percent a year through 2010. In the 20-year forecast period, international passenger traffic growth is projected to grow 7.8 percent a year while domestic traffic is predicted to increase 4.9 percent annually.

- The vigorous economic growth in Pacific/Asia will translate into robust passenger-traffic increases in that region. The North and Mid-Pacific route is forecast to grow at 11.6 percent per year from 1990 to 2010. Other fast-growing Pacific/Asia routes include Intra-Far East (10 percent) and Europe-Far East (8.1 percent).
- U.S. domestic passenger traffic growth will slow to an average annual rate of 4.2 percent through 2010. Nevertheless, this route will remain the largest market in the world throughout the forecast period.

## *Scheduled Passenger Traffic*

### *By Major Route*

| Route | 1990-2010 Average Growth (%) | Share of World RPKs (%) | |
|---|---|---|---|
| | | 1990 | 2010 |
| U.S. Domestic | 4.2 | 32.9 | 20.3 |
| North Atlantic | 4.5 | 12.0 | 7.8 |
| Europe-Far East | 8.1 | 7.9 | 10.1 |
| North and Mid Pacific | 11.6 | 7.7 | 18.9 |
| Intra-Far East and Pacific | 10.0 | 6.4 | 11.6 |
| Intra-Europe | 5.3 | 5.4 | 4.1 |
| Europe-Africa | 7.0 | 2.8 | 2.9 |
| Japan Domestic | 6.5 | 2.7 | 2.5 |
| Other Far East Domestic | 10.5 | 2.5 | 4.9 |
| North America-Central America | 5.8 | 2.0 | 1.7 |
| Total Major Routes | 6.9 | 82.3 | 84.8 |
| Total World* | 6.8 | 100.0 | 100.0 |

*Excludes U.S.S.R. Domestic

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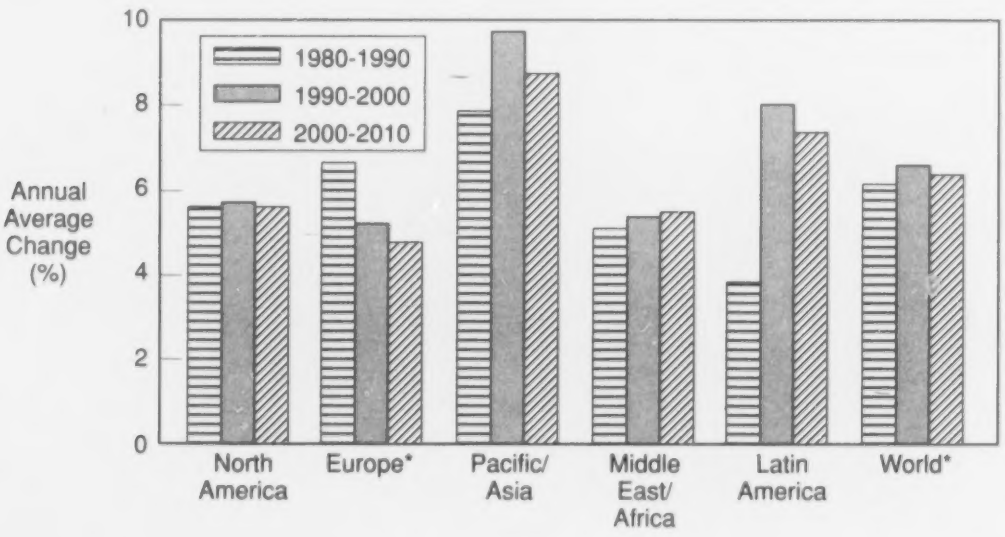
To forecast aircraft requirements, it is necessary to examine the future passenger traffic of individual carriers. Aggregating these RPK projections in terms of the 5 regional airline domiciles produces the following information:

- Passenger traffic will grow fastest for airlines located in Pacific/Asia, according to the forecast. Their average annual growth is expected to be 9.8 percent and 8.8 percent in the next two decades, respectively. In 2010, these carriers will fly just over 2 trillion RPKs, or about 31% of the world total.
- Fueled by strong economic growth, Latin American airlines are forecast to have the second-highest RPK increases, 8.1 percent from 1990 to 2000 and 7.4 for 2000 to 2010.
- Passenger traffic will grow at about the same rate for the remainder of the world's airlines. Carriers domiciled in North America, Middle East/Africa, and Europe are all forecast to have average annual RPK growth between 5 and 6 percent through 2010.
- Airlines headquartered in North America will still have the highest volume of passenger traffic in 2010, about 2.4 trillion RPKs, or 38 percent of the world total.

## *Passenger Traffic Growth, All Services*

***By Domiciled Region, Revenue Passenger-Kilometers***




*Excludes U.S.S.R.

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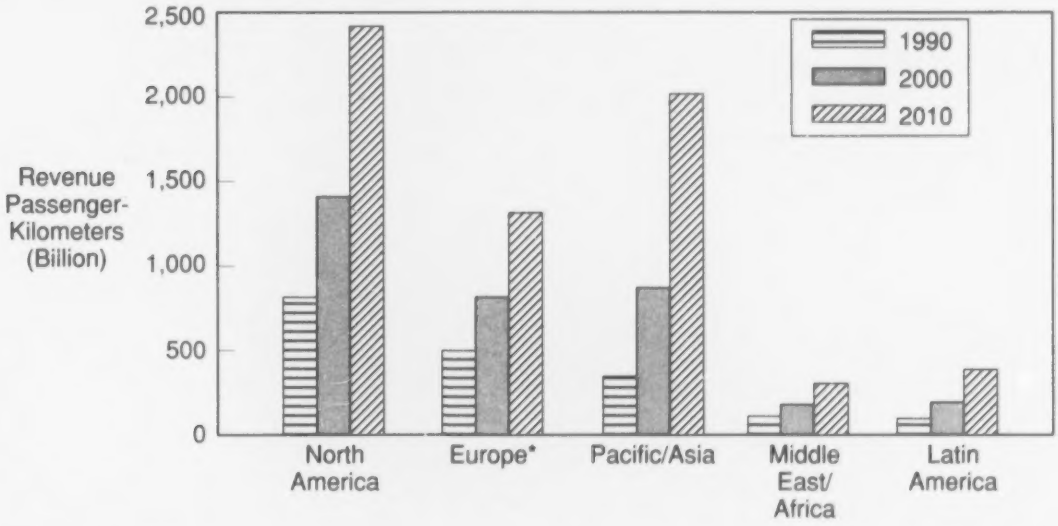
## *Passenger Traffic, All Services*

***By Domiciled Region***




*Excludes U.S.S.R.

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# Passenger Fleet Requirements

# Assumptions and Methods

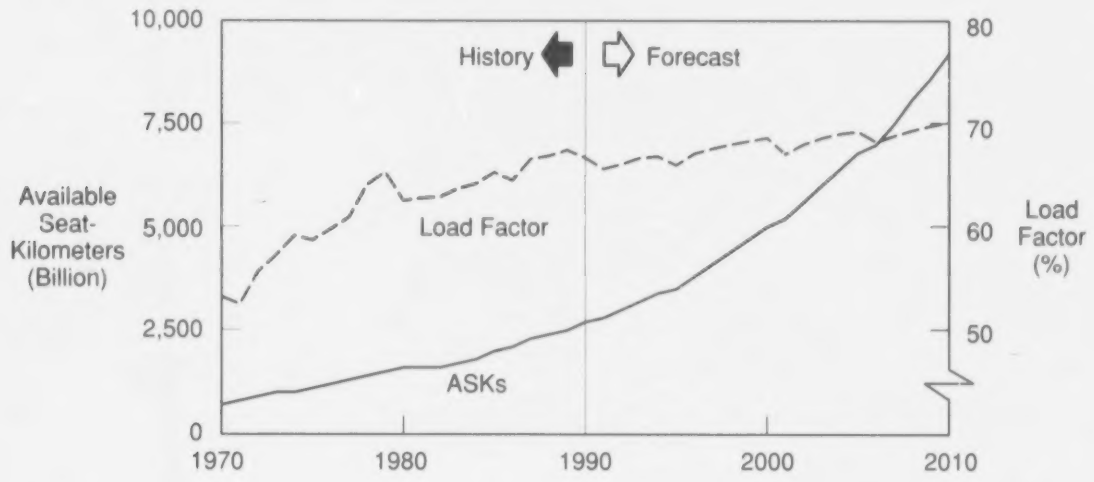
## Load Factor and Capacity Requirements

Passenger load factor is the percentage of available seat-kilometers filled by revenue passengers. This measure has trended upward over the past two decades, increasing nearly every year. For this period, the average, industry-wide load factor for both scheduled and nonscheduled services increased from 53 percent in 1970 to nearly 67 percent in 1990. Some of the reasons that carriers could increase the percentage of seats filled so dramatically include:

- Increased airline participation in more sophisticated computerized reservation systems
- Faster growth in regions with higher load factors, e.g., Pacific/Asia
- Improved airline scheduling and planning techniques
- The efficient application of hub-and-spoke operations
- The development and application of yield management

McDonnell Douglas forecasts that passenger load factors will not rise significantly in the near term, based on the relative balance of equipment arrivals, retirements, and traffic growth. In the long term, this variable is expected to continue to increase, although at a more modest rate than over the past two decades. Worldwide passenger load factor is forecast to reach approximately 70 percent by 2010.

### World Passenger Load Factor and ASKs




Excludes U.S.S.R.

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McDonnell Douglas combines load factor and RPK projections by airline to produce each carrier's required capacity, expressed in ASKs. Aggregated to a worldwide level, capacity requirements will grow by an average of 6.2 percent annually during the forecast period. By 2010, today's 2.8 trillion ASKs will have more than tripled to 9.2 trillion, according to the forecast.

## *Departures*

Aircraft departure growth largely determines the size of airplanes in the forecast, once capacity requirements are established. For a specific ASK level, a higher level of departures means that a greater number of aircraft will be added to the fleet, but they will be of smaller average seating capacity. For that same amount of capacity, a lower level of departures will result in the delivery of a smaller number of planes but of higher average seating capacity.

The choice of departure level is an important one for airlines. Greater frequencies attract passengers, especially high-yield business travelers. Fewer frequencies permit the use of larger planes with generally better operating economics per seat. Outside factors sometimes constrain airlines' choices. For example, bilateral agreements limit carriers' departures in certain markets. Another restriction on frequency growth is the congestion at such airports as London's Heathrow and Tokyo's Narita. Some airlines cope with such limitations by accommodating traffic growth with larger equipment. Other carriers buy smaller planes and offer more point-to-point service. These airlines relieve congestion at, for example, Narita, by offering nonstop flights to other Pacific/Asia destinations, instead of routing passengers through such a congested hub. This is the phenomenon of route dispersion, also called market fragmentation. Carriers implementing such an operating strategy require smaller planes with greater range, such as the MD-11.

## *Scheduled Passenger Services Departure Growth*

***By Major Route, Ranked by 1990 RPK Share***

| Route | Annual Average Growth (%) | | |
|---|---|---|---|
| | 1980-1990 | 1990-2000 | 2000-2010 |
| U.S. Domestic | 3.2 | 2.8 | 2.4 |
| North Atlantic | 7.2 | 3.9 | 3.3 |
| Europe-Far East | 15.9 | 4.6 | 4.3 |
| North and Mid Pacific | 9.4 | 10.0 | 8.8 |
| Intra-Far East and Pacific | 3.7 | 5.3 | 4.7 |
| Intra-Europe | 3.9 | 3.9 | 3.1 |
| Europe-Africa | 0.7 | 2.6 | 2.2 |
| Japan Domestic | 3.5 | 3.3 | 3.1 |
| Other Far East Domestic | 10.2 | 5.7 | 4.8 |
| North America-Central America | 6.9 | 4.3 | 4.1 |
| Total Major Routes | 3.9 | 3.8 | 3.4 |
| Total World* | 3.6 | 3.7 | 3.4 |

*Excludes U.S.S.R. Domestic

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McDonnell Douglas forecasts departures for each airline in our world fleet, relying heavily on carriers' existing operational networks and expansion plans. A key input to this process is the prediction of average departure growth by route, e.g., the North Atlantic. On this basis, departures are forecast using regional econometric models. These tools relate historical departures to corresponding values for capacity, jet fuel prices, and other relevant variables. In most regions, departures are forecast to grow at 50 percent to 80 percent of the rate of ASKs, with total world departures growing at 60 percent of the rate of available seat-kilometers, on average.

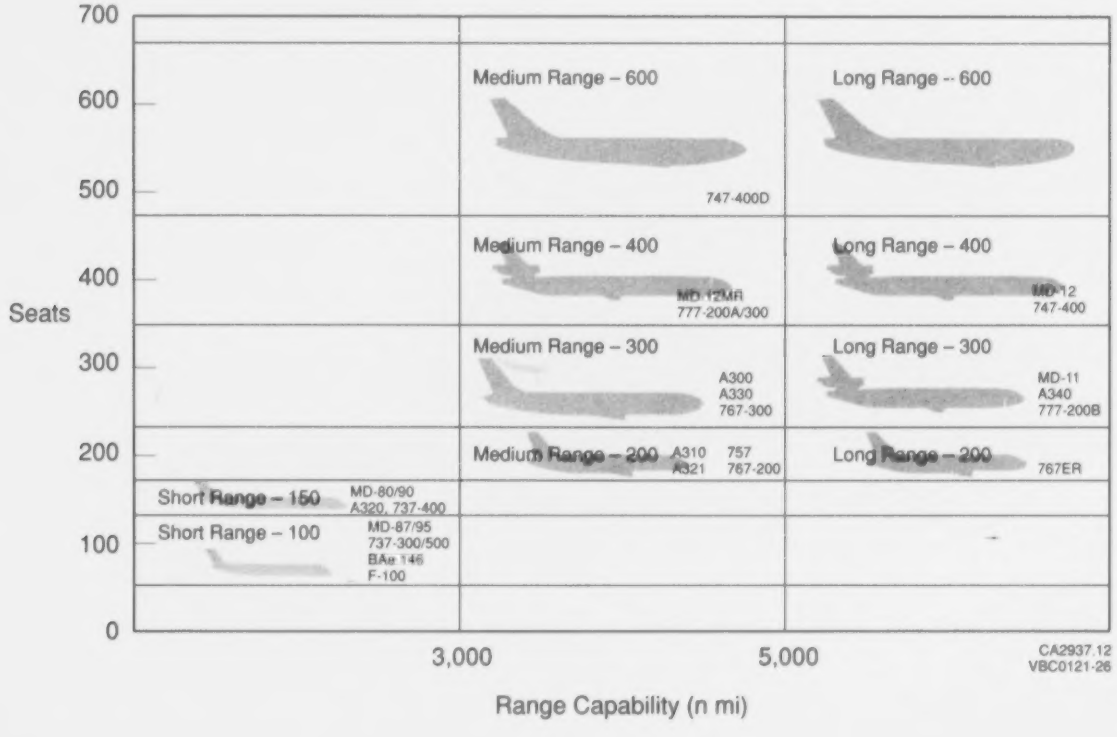
World departures are forecast to increase at an annual average rate of 3.7 percent over the next decade and 3.4 percent between 2000 and 2010. These growth rates are very similar to the last decade's 3.6 percent.

## *Generic Passenger Aircraft Classes*

Airline fleet requirements are forecast for the 10 McDonnell Douglas generic aircraft classes. Each is based on airplane seating capacity and range capability. Existing and planned airplane models are grouped into these 10 classes based upon typical two-class seating configurations for short- and medium-range aircraft and typical three-class seating for long-range jets. For example, the MD-80 belongs to the Short Range-150 (S150) generic class and the MD-11 fits into the Long Range-300 (L300) category. Please see the Appendix for a detailed list of aircraft models in each class. For forecast purposes, deliveries of Long Range-600 (L600) aircraft are assumed to begin in the year 2000.

## *Passenger Aircraft Classes*

***As Defined by McDonnell Douglas***



# *Passenger Aircraft Fleet*

The world's jet aircraft fleet has continued to expand, providing the necessary capacity to transport the growing number of commercial passengers. Between 1970 and 1990, the number of passenger jetliners in service grew at an annual average rate of 6 percent, approaching 8,000 aircraft by 1990. (All annual aircraft data in this publication relate to year-end fleets.)

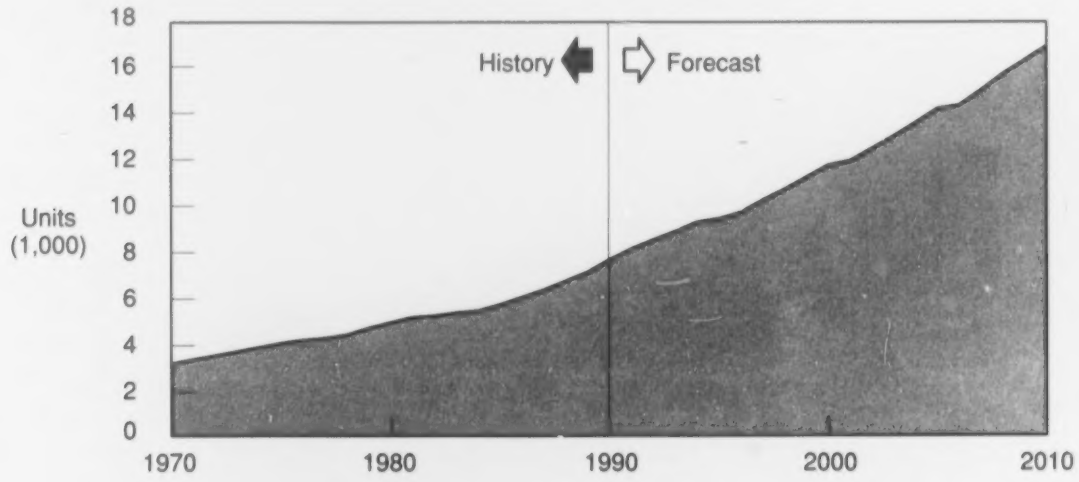
With long-term capacity requirements (ASKs) forecast to expand at an annual average rate of 6.2 percent through 2010, substantial fleet growth will be required.

- Between 1990 and 2010, the world passenger fleet will grow at an annual average rate of 4 percent
- By 2010, nearly 17,000 passenger aircraft will be in operation by commercial carriers

The projected rate of fleet development will be more pronounced during the first half of the forecast period, with growth in this decade averaging 4.4 percent per year. Between 2000 and 2010, the increase in the fleet will slow to 3.7 percent annually as deliveries shift to favor larger aircraft.

## *World Passenger Aircraft Fleet*

***Active Commercial Service, Jets Only***




Note: Historical Fleet Data Estimated Due to Airline Mergers, Bankruptcies, etc.

Excludes U.S.S.R.

CA2937.16
VBC0121-22

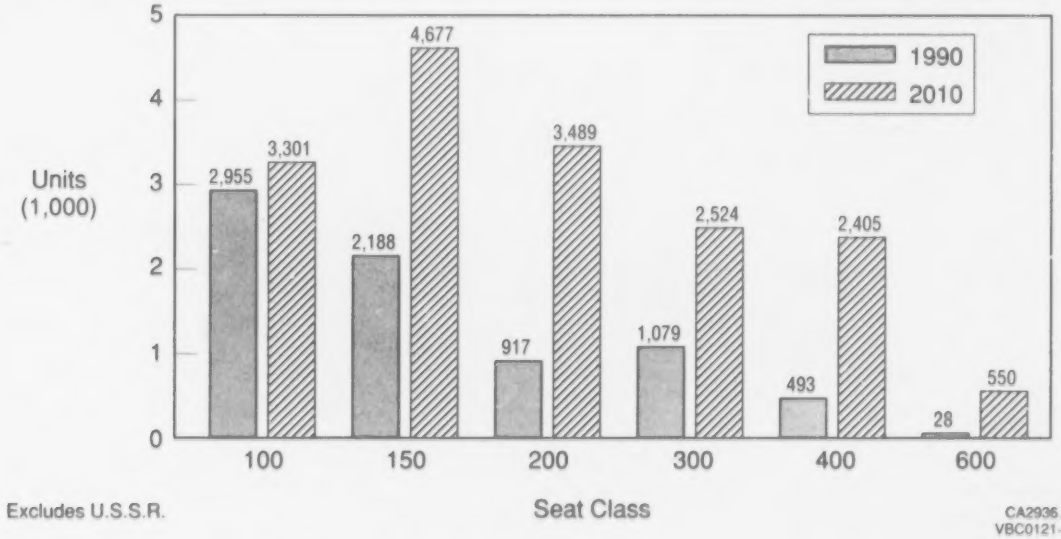
Growth in capacity requirements combines with regional departure increases and airline range requirements to determine tomorrow's fleet. On almost all routes, departures are forecast to grow more slowly than capacity, and average aircraft size will increase. Thus, the average seating capacity of airplanes in the fleet will increase.

- The 600-seat class will show the greatest proportional increase, nearly twentyfold. From just a few, high-density jets today, the fleet is expected to grow to 550 units of this size, constituted mainly of new aircraft models.
- The 400-seat class will expand nearly fivefold. Undoubtedly, new models, such as the MD-12, will join the single type in this size class today.
- The 300-seat class will more than double from today's fleet to 2,524 units in 2010.
- The 200-seat class will add the largest number of units to its fleet, nearly quadrupling in size, and by 2010 it will be the second-largest category of commercial jets at 3,489 units.
- The 150-seat class will become the most popular capacity airplane by the end of the forecast period, reaching a fleet of nearly 4,700 aircraft.
- The 100-seat class will show the smallest fleet expansion, rising only 12 percent. By 2010, this size class will fall from first to third in the total fleet.

The increased popularity of larger aircraft will increase average seats per aircraft from 188 in 1990 to 248 by 2010 worldwide. Thus, average aircraft seating capacity will expand by three seats each year.

## *World Passenger Fleet*

***By Seat Class***




Excludes U.S.S.R.

CA2936.16
VBC0121-14

Intercontinental markets are anticipated to develop rapidly, especially in the North and Mid Pacific and Europe-Far East. To operate on such long-haul routes, airlines will require many long-distance airplanes. There were 999 long-range jetliners in service in 1990, accounting for only 13 percent of the worldwide fleet. By 2010, aircraft with such capability will comprise over 23 percent of the total fleet, nearly quadrupling their numbers to 3,913.

The number of short- and medium-range aircraft in service will nearly double in the forecast period. Although still substantial, this slower growth is a direct result of the lower-than-average traffic increases in domestic routes and on the North Atlantic.

## *World Passenger Fleet*

### *By Range*

Excludes U.S.S.R.

CA2936.01
VBC0121-1

Airlines domiciled in Pacific/Asia will enjoy the highest traffic growth rates, as detailed in the World Environment for Airlines section of this report. This increase in RPKs will require an extensive expansion of these airlines' fleets.

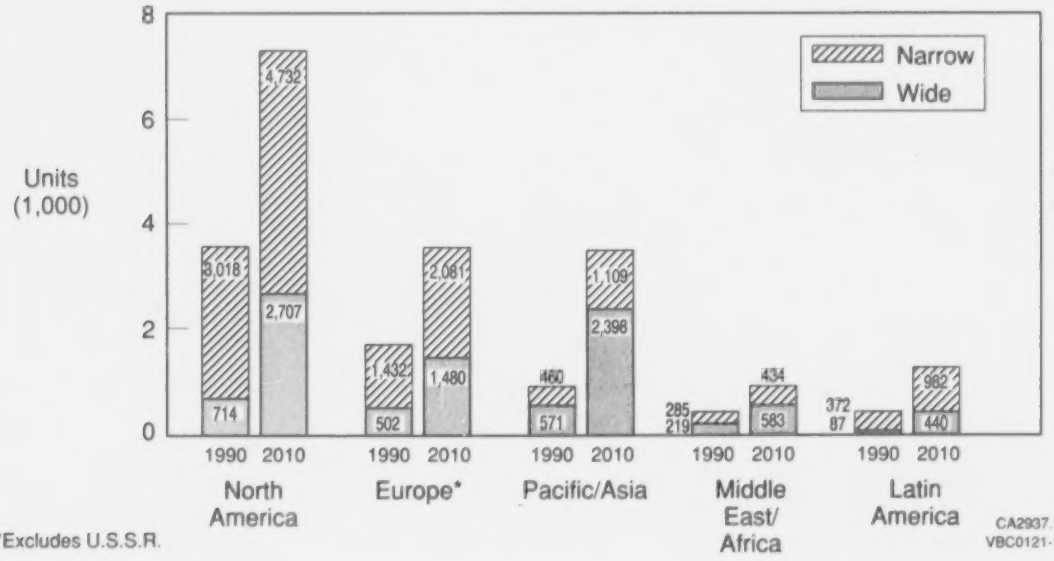
- Pacific/Asia-based fleets will increase at the fastest rate of any region, ending up nearly three-and-one-half times their current size in 2010. These fleets will grow from their current 13-percent share of the world total to 21 percent in the next 20 years.
- By 2010, the Pacific/Asia-domiciled fleet will be nearly the size of that domiciled in Europe (excluding the U.S.S.R.). Pacific/Asia wide-bodies in 2010 will be nearly as numerous as those domiciled in North America.

Other noteworthy regional changes include the following:

- The North American fleet will still be the largest in the world at the end of the forecast period. Despite virtually doubling their aircraft units in the next 20 years, North American airlines' share of the world fleet will decline from 49 percent to 44 percent by 2010.
- European airlines' fleets will nearly double in size in the next two decades. The number of aircraft domiciled in this region will slightly exceed the number belonging to Pacific/Asia carriers.
- Latin America has the second-highest forecast rate of traffic growth. It also ranks second in proportional fleet growth between 1990 and 2010, with total airplane count more than tripling.
- The Middle East/Africa fleet will double by 2010. Yet this region will have the smallest number of airplanes by this year.

## *Passenger Fleet*

### *By Domiciled Region*




*Excludes U.S.S.R.

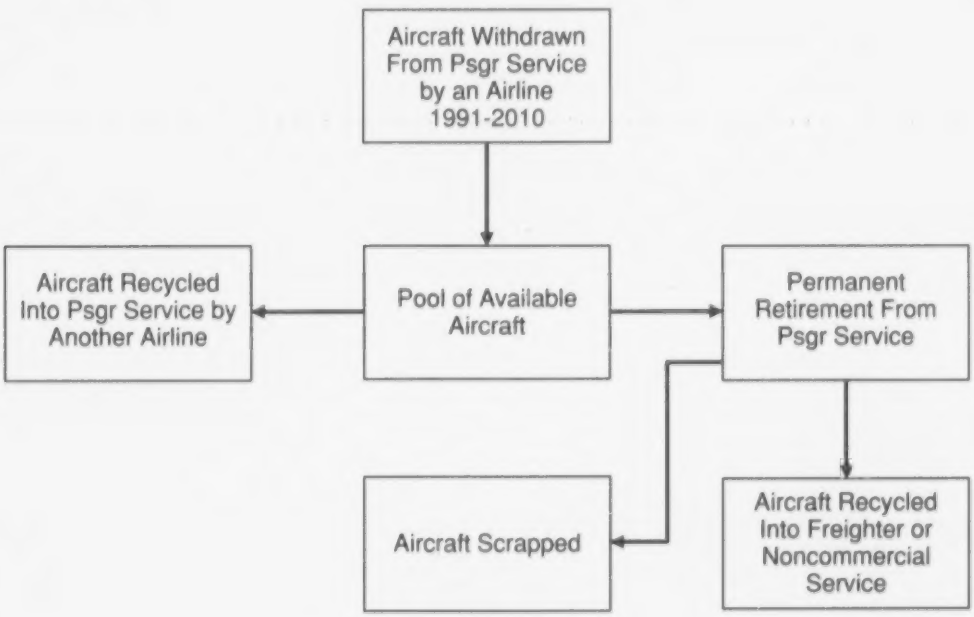
# *Aircraft Retirements*

Except for traffic growth, aircraft retirements are the most significant factor in determining airlines' future delivery requirements. Retirement forecasting is usually done by applying an assumed maximum aircraft life. But such a simple rule can miss many important factors. Existing legislation, specific airline policies, tax considerations, and the cost of maintaining aging aircraft are all important elements in each airline's decisions to retire or retain older planes and to buy new or used equipment.

## *McDonnell Douglas Aircraft Retirement Model*

To capture the impact of these interrelated factors, McDonnell Douglas has recently developed a discrete-time simulation model of aircraft retirements. This computer tool has significantly improved our ability to forecast the disposition of used planes. This capability, in turn, should enhance the accuracy of our prediction of airlines' requirements for new equipment.

## *Structure of Aircraft Retirement Model*


Aircraft Withdrawn From Psgr Service by an Airline 1991-2010
Aircraft Recycled Into Psgr Service by Another Airline
Pool of Available Aircraft
Permanent Retirement From Psgr Service
Aircraft Scrapped
Aircraft Recycled Into Freighter or Noncommercial Service

CA2937.07
VBC0121-27

Here is a top-down view of the operation of the McDonnell Douglas Aircraft Retirement Model. First, retirement schedules are developed for each carrier based on its stated policies, the equipment that it currently has on firm order, and its historical behavior. These schedules are consistent with existing U.S. rules and European guidelines regarding older aircraft, detailed below. They also consider each airline's financial decision to retire, re-engine, or hush-kit used equipment. As jetliners leave the fleet of an individual carrier, the model places them into a pool of available used aircraft for recycling to other passenger carriers. Planes are only taken into another airline's passenger fleet if three criteria are satisfied:

- The airline acquiring the used plane must have a requirement for equipment of this type. It also must have a retirement policy that permits a minimum of 3 years' service from the used aircraft.
- There is a ceiling on the proportion of used equipment that each airline will buy. This carrier-specific fraction is mainly based on historical fleet acquisition patterns.
- U.S. rules and European guidelines concerning older aircraft must not be violated.

For every year of the forecast, the model attempts to place all used planes in the pool into the fleets of every airline except the one just retiring it. (Leaving planes in the pool is analogous to storing them on the ground.) Used planes that are never placed into other airlines' passenger fleets are considered to be permanently retired from passenger service. These jets are then available to be converted into freighters, placed into noncommercial use, transferred to smaller airlines not in the McDonnell Douglas world fleet, or scrapped.

## *Legislation Concerning Older Aircraft*

The McDonnell Douglas Aircraft Retirement Model was developed to forecast the status of used aircraft consistent with existing legislation. Included are the noise regulations affecting U.S. carriers and the guidelines applying to European airlines.

The Federal Aviation Administration allows U.S. carriers the option of following either a phaseout or phase-in schedule. The phaseout schedule requires airlines to reduce their 1990-91 Stage 2 fleet by 25 percent through 1994, 50 percent by 1996, 75 percent by 1998, and operate none such aircraft by 1999. The phase-in schedule requires carriers' Stage 3 aircraft to represent 55 percent of their fleet by 1994, 65 percent by 1996, 75 percent by 1998, and 100 percent by 1999. The phaseout approach was utilized in modeling retirements for U.S. airlines since the phase-in schedule was not fully defined when this forecast was prepared. Furthermore, this retirement forecast assumes a limited amount of retrofitting of older planes to meet Stage 3 noise standards. Finally, because U.S. rules prohibit the importation of Stage 2 jets from other countries, the model does not allow such recycling.

The European Commission guidelines recommend a gradual phaseout of Chapter 2 aircraft between April 1995 and 2002, based on aircraft reaching 25 years of age. Planes under 25 years of age need not be prematurely phased out before 2002. Chapter 2 wide-body equipment is allowed to remain in service through 2002, regardless of age. Airlines from developing European nations may continue to own and operate Chapter 2 jets after 2002, providing they have plans for replacing these aircraft with Chapter 3 transports. As in the U.S., European rules forbid the importation of Chapter 2 equipment. Therefore, the model also does not permit such recycling into carriers domiciled in Europe.

## *Aircraft Retirement Results*

The results from the McDonnell Douglas Aircraft Retirement Model show that 4,736 jetliners will be permanently retired from active passenger service over the next 20 years. Short-range aircraft predominate this activity. Nearly 70 percent of the total units withdrawn from the passenger fleet are in this category.

The S100 class accounts for 43 percent of total units leaving active service. This category dominates permanent retirements because of the withdrawal of small jets first delivered in the late 1960s: 727-100s and early model DC-9s and 737s. These "workhorses" will be retired mainly in the 1990s in response to the U.S. and European regulations detailed above. Today's S150 fleet is 25 percent smaller and somewhat younger than the planes in the S100 category. Permanent retirements from the active passenger fleet of S150s are 26 percent of total units. Most retirements in this class are 727-200s.

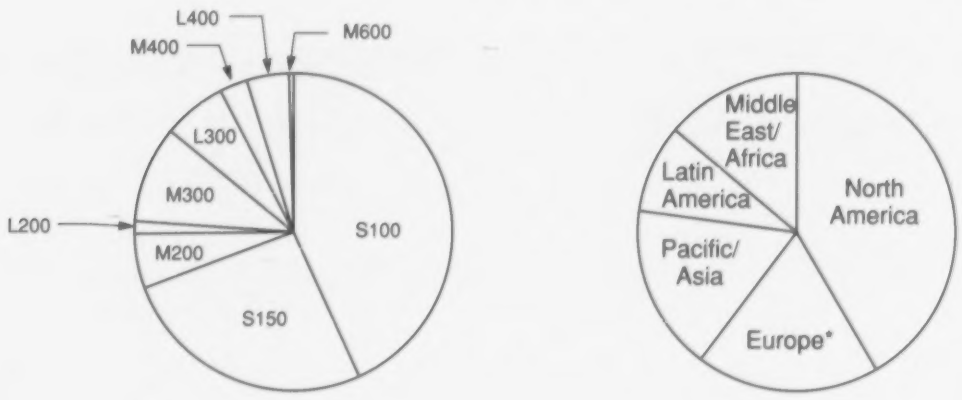
Wide-body aircraft represent only 27 percent of the total units leaving passenger service permanently. Retirements of these larger jets are in proportion to their representation in today's fleet. The bulk of wide-body retirements is from the M300 and L300 generic classes, mainly DC-10s, L-1011s, and A300s.

North America currently operates nearly half of the world's commercial fleet. This region also accounts for a high proportion of permanent retirements, nearly 42 percent. Europe, with one-fourth of the world's commercial jets, will retire 19 percent of the total. Because they retire planes sooner, carriers domiciled in Pacific/Asia will account for 17 percent of permanent retirements, while their combined fleets represent just over 13 percent of the aircraft in the world.

In summary, 62 percent of the world's currently active passenger fleet will be permanently retired by 2010. On average, 237 new aircraft will be required each year just to replace these planes.

## *World Passenger Aircraft Permanent Retirements*

***By Generic Class and Domiciled Region, 1991-2010***



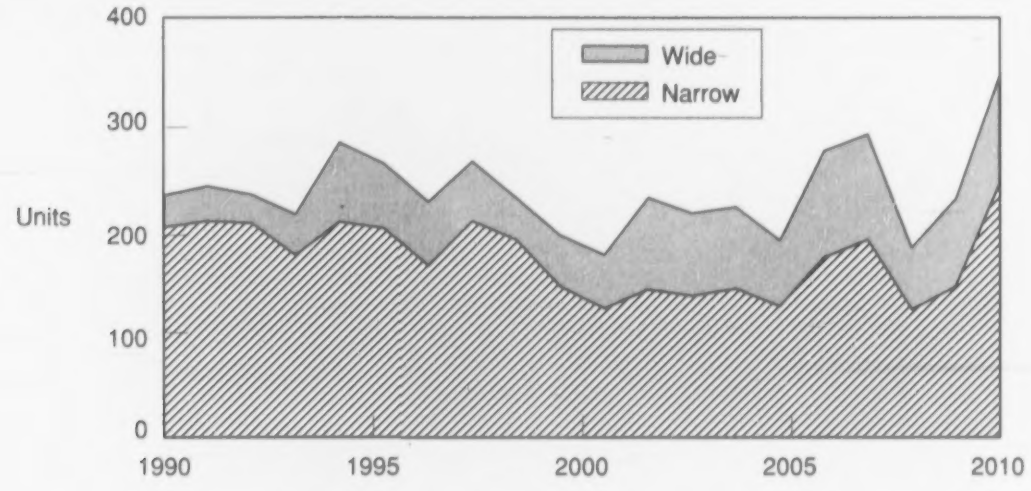

4,736 Units

*Excludes U.S.S.R.

CA2936.07
VBC0121-7

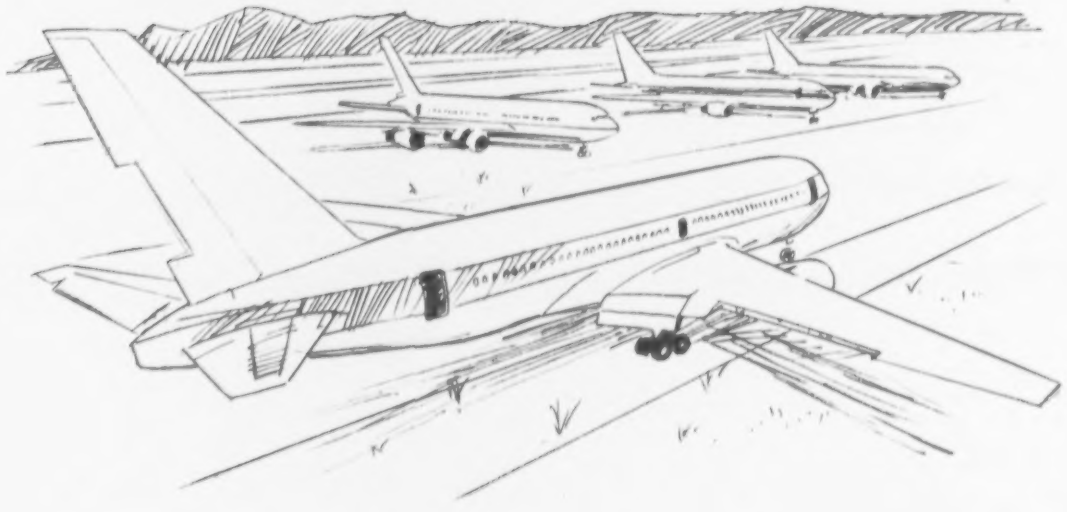
## *World Passenger Aircraft Permanent Retirements*

***By Fuselage Type***




Excludes U.S.S.R.

CA2937.02
VBC0121-21



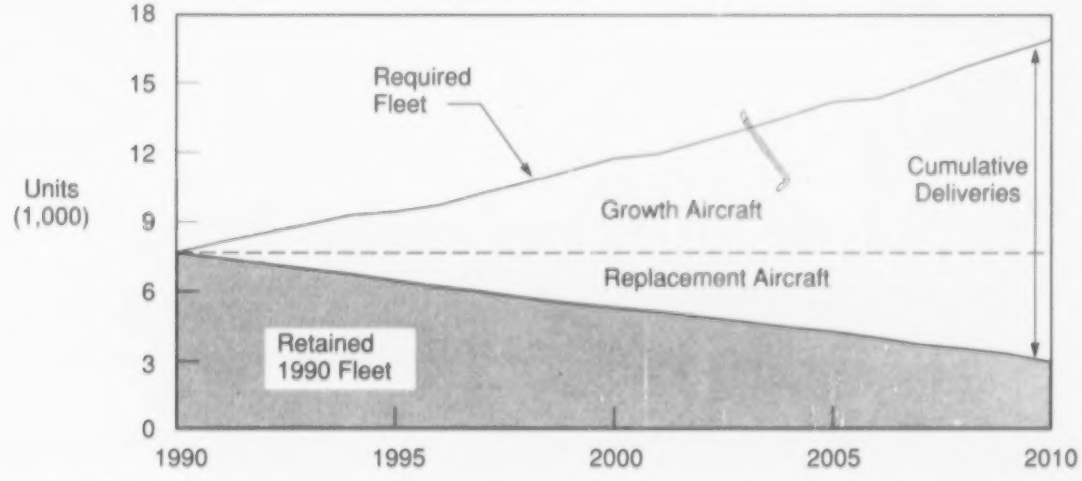
# *Passenger Aircraft Delivery Requirements*

McDonnell Douglas determines the number of new aircraft required by airlines using the following approach. Delivered planes both replace permanent retirements and accommodate growth, resulting in sufficient capacity so that the forecast load factor is met. This procedure is followed for 55 individual airlines and five aggregates of 163 smaller carriers for each of the 20 years in the forecast period. The results for all these carriers, between 1991 and 2010, are as follows:

- New passenger aircraft delivery requirements will total 14,022 units.
- These planes will cost nearly $943 billion (expressed in constant 1990 U.S. dollars).
- More than 4,700 of these deliveries (34 percent) will be for replacement purposes.
- Nearly 9,300 of these deliveries (66 percent) will be made to allow for growth.

## *Delivery Requirement Composition*

***World Passenger Aircraft***




Excludes U.S.S.R.

CA2937.15
VBC0121-20

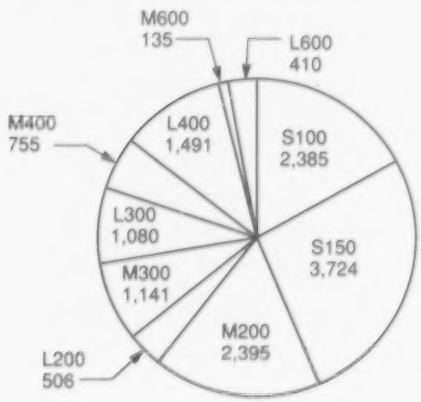
New aircraft deliveries also serve to maintain or adjust the mix of sizes of planes within airlines' fleets and to satisfy their requirements for equipment with additional range capability. Examining the delivery forecast in terms of the 10 McDonnell Douglas generic aircraft classes shows the following:

- In terms of units to be delivered, smaller airplanes still dominate. Despite airlines' somewhat modest fleet expansion requirements for S100 and S150 aircraft, these two classes combine to be 44 percent of total units delivered through 2010. The continued strong requirements for new, small jets is caused by the forecast permanent retirement of 3,274 S100 and S150 units over the next two decades. Yet aircraft in these sizes account for just 21 percent of the value of all deliveries.

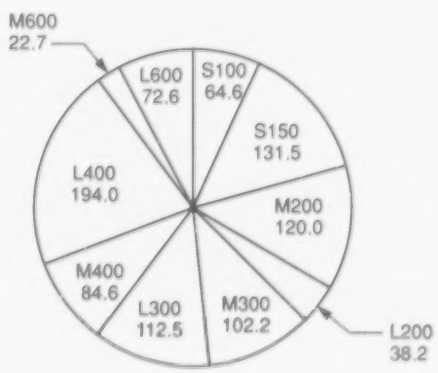
- In terms of the dollar value to be delivered, large, long-range wide-bodies predominate. The L300, L400, and L600 classes comprise more than 40 percent of airlines' equipment expenditures over the forecast period, or nearly $380 billion (constant 1990 dollars). Over half the dollar value of these planes is concentrated in L400s. This single class is forecast to have more than 20 percent of the value of all deliveries over the next 20 years, worth nearly $200 billion (constant 1990 dollars).

## *World Passenger Aircraft Deliveries*

***By Generic Class, 1991-2010***




14,022 Units




$942.9 Billion
(Constant 1990 Dollars)

Excludes U.S.S.R.

CA2936.03
VBC0121-3

When comparing domiciled delivery units to delivery values, broad differences occur because of the higher unit cost of wide-body aircraft. In the following section, domiciled regions are listed in decreasing order of the dollar value of their passenger aircraft deliveries.

## *North America*

This region far exceeds all others in passenger aircraft deliveries through 2010, having 40 percent of the world total. But most of these planes will be in the smallest two generic classes, S100 and S150. In terms of value of aircraft delivered in the forecast period, North America has 33.6 percent of the world total, just ahead of the percentage for airlines domiciled in Pacific/Asia.

## *Pacific/Asia*

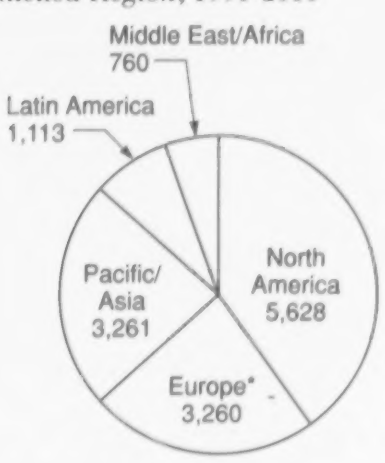
Airlines located in this region will require 3,261 new passenger plane deliveries in the next two decades, or 23.3 percent of the world total. This is almost the same number of units required by the air carriers of Europe, omitting the U.S.S.R. But Pacific/Asia airlines' requirements will be concentrated in high-capacity, wide-body jetliners. Thus, their deliveries' value will exceed $300 billion (constant 1990 dollars) and reach one-third of the world total on this basis.

## *Europe*

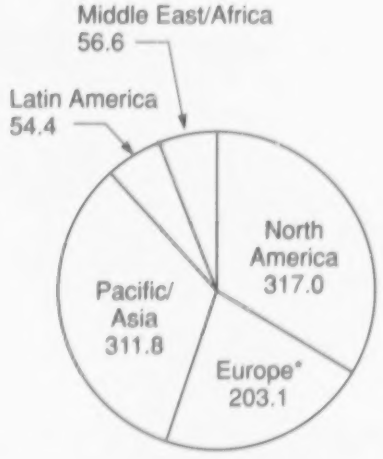
European carriers will require the most balanced size-mix of passenger aircraft deliveries. Thus, this domiciled region's share of units and their dollar value are nearly identical, 23.2 percent and 21.5 percent, respectively.

### *Passenger Aircraft Deliveries*

***By Domiciled Region, 1991-2010***




14,022 Units




$942.9 Billion
(Constant 1990 Dollars)

*Excludes U.S.S.R.

CA2936.09
VCB0121-9

## *Middle East/Africa*

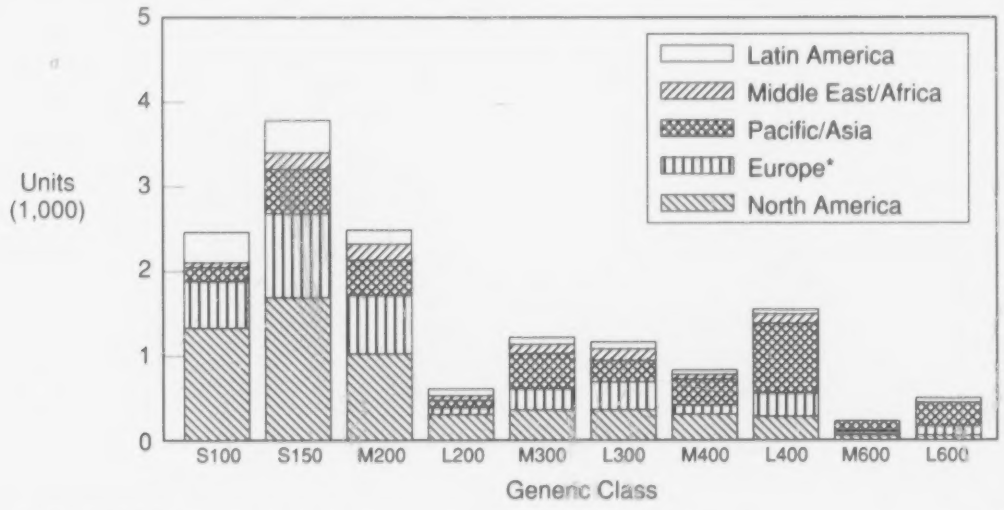
The relatively modest traffic forecast for airlines domiciled in this region means that only 5.4 percent of passenger aircraft units will be delivered there between 1991 and 2010. But the range requirements of carriers in Middle East/Africa means that a large proportion of these jets will be in the L300 and L400 classes. Thus, in dollar value, airlines in this region will receive 6 percent of all passenger deliveries or $56.6 billion (constant 1990 dollars).

## *Latin America*

Passenger traffic for airlines domiciled in this region is forecast to grow at a substantial rate with their domestic routes increasing faster than international ones. Therefore, passenger aircraft deliveries in this domiciled region will be dominated by smaller planes, especially those in the S100 and S150 classes. In terms of units, Latin America will receive 7.9 percent of deliveries. In terms of their dollar value ($54.4 billion), these planes will amount to 5.8 percent of the world total.

## *Passenger Aircraft Deliveries*

***By Domiciled Region and Seat Class, 1991-2010***




*Excludes U.S.S.R.

CA2936.15
VBC0121-13

Examining delivery requirements over time results in the following observations:

- There is a gradual shift to deliveries of larger planes throughout the forecast period.
- Noise rules in the U.S. and guidelines in Europe will increase S100 and S150 delivery requirements during the 1996-2000 period, as older, noisier aircraft are replaced.
- The rate of delivery requirements continues to increase throughout the forecast, rising from just under 3,000 in the first 5 years to just over 4,000 in the last period.

## *World Passenger Aircraft Deliveries*

| Generic Class | 1991-1995 | 1996-2000 | 2001-2005 | 2006-2010 | Total |
|---|---|---|---|---|---|
| S100 | 771 | 698 | 468 | 448 | 2,385 |
| S150 | 892 | 1,082 | 934 | 816 | 3,724 |
| M200 | 462 | 612 | 578 | 743 | 2,395 |
| L200 | 156 | 155 | 91 | 104 | 506 |
| M300 | 164 | 187 | 310 | 480 | 1,141 |
| L300 | 258 | 219 | 312 | 291 | 1,080 |
| M400 | 24 | 167 | 247 | 317 | 755 |
| L400 | 246 | 368 | 407 | 470 | 1,491 |
| M600 | 6 | 17 | 18 | 94 | 135 |
| L600 | 0 | 5 | 128 | 277 | 410 |
| Total | 2,979 | 3,510 | 3,493 | 4,040 | 14,022 |

Excludes U.S.S.R.

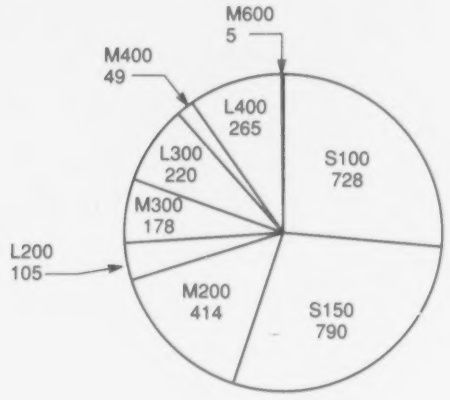
CA2937.09
VBC0121-30

# *Passenger Aircraft Firm Orders*

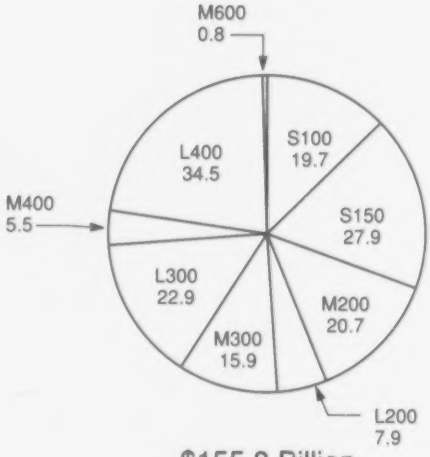
On April 30, 1991, a total of 2,754 passenger jets were on firm order for deliveries starting on January 1, 1991. This total includes orders placed by leasing companies that have been assigned to operator-airlines. (Unassigned leasing company aircraft purchases are excluded from this figure.) Slightly more than half these orders are in the S100 and S150 classes. In terms of dollar value, long-range, wide-body jets dominate undelivered orders. The L300 and L400 classes comprise over 36 percent on this basis.

## *World Passenger Aircraft Firm Orders*

***By Generic Class***




2,754 Units




$155.8 Billion
(Constant 1990 Dollars)

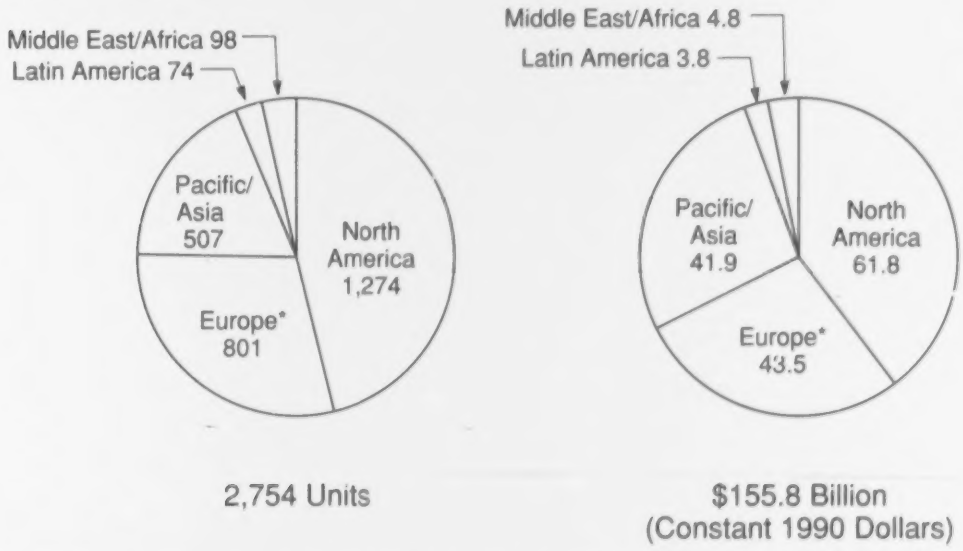
Includes Orders Placed Through April 30,1991 for Deliveries Beginning January 1991
Excludes U.S.S.R. and Unassigned Leasing Company Orders

CA2936.05
VBC0121-5

North American operators have the largest share of aircraft currently on order, both in terms of units (46.3 percent) and value (39.7 percent). European airlines rank second in undelivered orders, also in terms of both units (29.1 percent) and value (27.9 percent). Pacific-Asia carriers are close to those in Europe in terms of dollar value of firm orders (26.9 percent) but place a more distant third based on units (18.4 percent). Added together, airlines domiciled in Middle East/Africa and Latin America have just 6.2 percent of the units and 8.6 percent of the dollar value of undelivered firm orders.

## *Passenger Aircraft Firm Orders*

***By Domiciled Region***




Includes Orders Placed Through April 30,1991 for Deliveries Beginning January 1991
Excludes Unassigned Leasing Company Orders

*Excludes U.S.S.R.

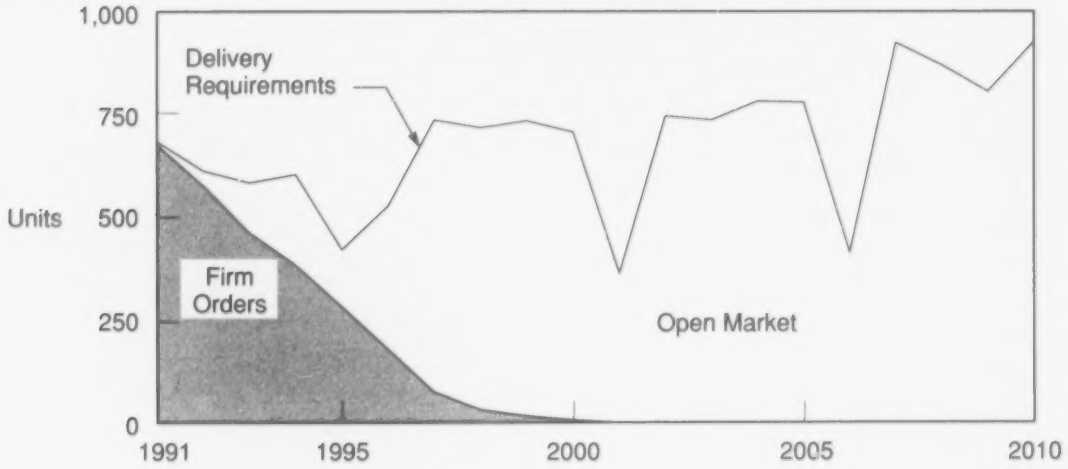
CA2936.06
VBC0121-6

# *Passenger Aircraft Open Market*

The open market for passenger aircraft is the difference between forecast deliveries and existing firm orders. In other words, these are the orders left to be booked by manufacturers. Through 2010, the open market is forecast to be 11,268 units, valued at $787 billion (constant 1990 dollars). Like the other measures of airline equipment requirements presented in this report, open market is stated in terms of aircraft delivery years. The delivery troughs reflect forecast world recessions affecting growth requirements for aircraft. Actual production levels will follow a smoother path.

## *World Open Market for Passenger Aircraft*

*1991-2010*



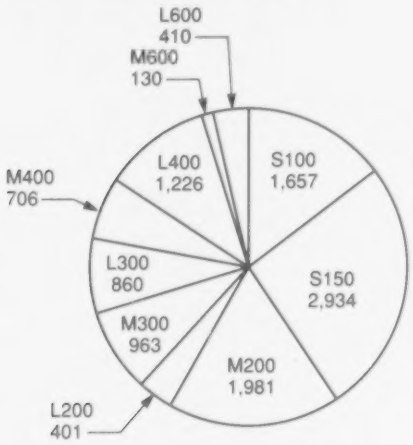

Excludes U.S.S.R.

CA2937.14
VBC0121-18

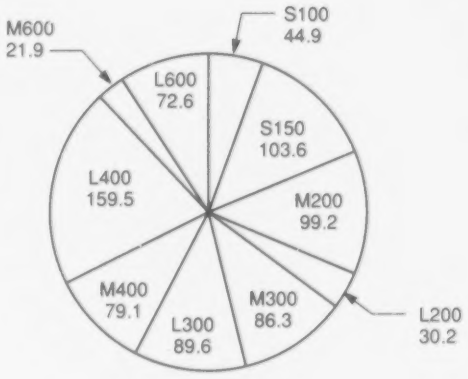
The open market for commercial passenger aircraft represents 80 percent of the units and 83 percent of the dollar value of the forecast of airlines' delivery requirements. Current orders represent a broad cross section of aircraft sizes and range capabilities. Therefore, the distribution of the open market by generic class is very similar to that presented above for deliveries.

## *World Passenger Aircraft Open Market*

### *By Generic Class, 1991-2010*




11,268 Units




$786.9 Billion
(Constant 1990 Dollars)

Excludes U.S.S.R.

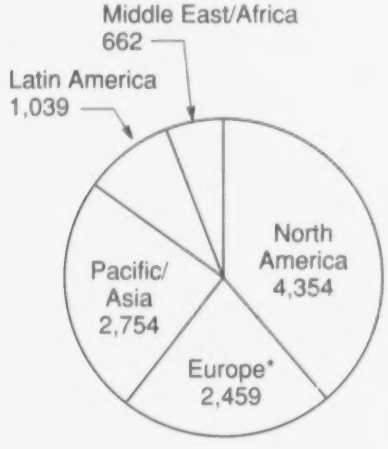
CA2936.04
VBC0121-4

Regions are listed below in decreasing order of the dollar value of their passenger aircraft open market.

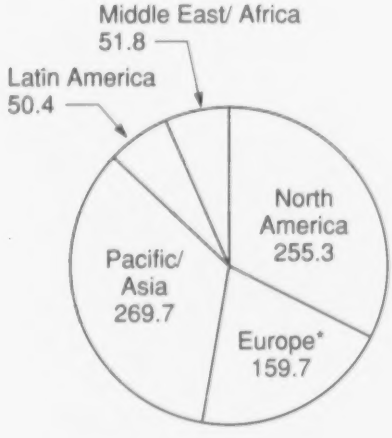
- Pacific/Asia is the leader in terms of aircraft open market value with 34.3 percent of the world total, amounting to $269.7 billion (constant 1990 dollars). In units, this region is second to North America.
- North America is second in terms of equipment open-market value with 32.4 percent of the total, amounting to $255.3 billion (constant 1990 dollars). Based on units of passenger planes yet to be booked, this region is still first.
- The airplane open market for airlines domiciled in Europe is 20.3 percent of the world total in value terms, $159.7 million (constant 1990 dollars). Europe's share is approximately the same (21.8 percent) based on units.
- Middle East/Africa's open market for aircraft amounts to 6.6 percent of the world total in terms of future expenditures. These are forecast to be $51.8 billion (constant 1990 dollars) through 2010.
- Latin American airlines have nearly the same open market for new jets in value terms as those in Middle East/Africa, $50.4 billion (constant 1990 dollars), representing 6.4 percent of the world.

## *Passenger Aircraft Open Market*

***By Domiciled Region, 1991-2010***




11,268 Units




$786.9 Billion
(Constant 1990 Dollars)

*Excludes U.S.S.R.

CA2936.06
VBC0121-8

With manufacturers' order books reasonably full for the next few years, the open market for deliveries through 1995 is somewhat modest, totaling just 538 jets. Nearly half these planes are in the S100 and S150 classes.

Between 1996 and 2000, the situation is very different. Airline delivery requirements for this 5-year period total 3,510 units while only 313 aircraft are on firm order. Thus, the open market is an impressive 3,197 units. Just over half these airplanes are S100s and S150s. But the open market for large, long-range wide-bodies in these 5 years is substantial (534 units), especially when considered in terms of their value.

As of April 30, 1991, there were no firm orders placed for delivery after the year 2000. Therefore, from 2001 on, the open market for commercial jets is the same as airline delivery requirements.

## *World Passenger Aircraft Open Market*

| Generic Class | 1991-1995 | 1996-2000 | 2001-2005 | 2006-2010 | Total |
|---|---|---|---|---|---|
| S100 | 69 | 672 | 468 | 448 | 1,657 |
| S150 | 176 | 1,008 | 934 | 816 | 2,934 |
| M200 | 130 | 530 | 578 | 743 | 1,981 |
| L200 | 52 | 154 | 91 | 104 | 401 |
| M300 | 25 | 148 | 310 | 480 | 963 |
| L300 | 42 | 215 | 312 | 291 | 860 |
| M400 | 8 | 134 | 247 | 317 | 706 |
| L400 | 35 | 314 | 407 | 470 | 1,226 |
| M600 | 1 | 17 | 18 | 94 | 130 |
| L600 | 0 | 5 | 128 | 277 | 410 |
| Total | 538 | 3,197 | 3,493 | 4,040 | 11,268 |

Excludes U.S.S.R.

CA2937.08
VBC0121-29

# Cargo Fleet Forecast

# *Cargo Industry Overview*

Air cargo produces 13.5 percent of the airlines' operating revenues worldwide. The cargo business has often been relegated to a distant second place in world aviation. Nevertheless, it is quietly assuming a larger role in the industry. Over the past 20 years, air cargo has grown 1.5 percentage points faster than passenger traffic on an annual average basis. As international trade, partnerships, and manufacturing expand, the movement of goods by air will assume a higher profile. The forecast envisions a world where air cargo is a linchpin of continued economic growth.

The current world economic slowdown dramatized international commercial interdependence. The downturn reduced trade and this decline, in turn, diminished air cargo almost immediately. Businesses everywhere are moving to just-in-time inventory systems and computerized links between the manufacturing point of origin and the retail point of sale. These approaches link today's air cargo traffic level to yesterday's manufacturing rate and to last week's retail sales.

Almost as soon as the world's economies recover, the demand for air cargo will surge. This growth in tonne-kilometers will be met by a more productive industry. The innovations of the air express business will soon find their way into the movement of heavy freight. Productivity will increase because new computer systems for tracking and scheduling shipments will be developed and installed. New-generation aircraft will carry cargo farther and more economically.

But there are challenges ahead for the air cargo industry. Regional protectionism threatens to slow growth in international trade. Lengthy customs procedures are increasingly an obstacle to computer-linked, next-day air deliveries. Small-package service often faces lengthy customs delays while fax machines transmit literally at the speed of light.

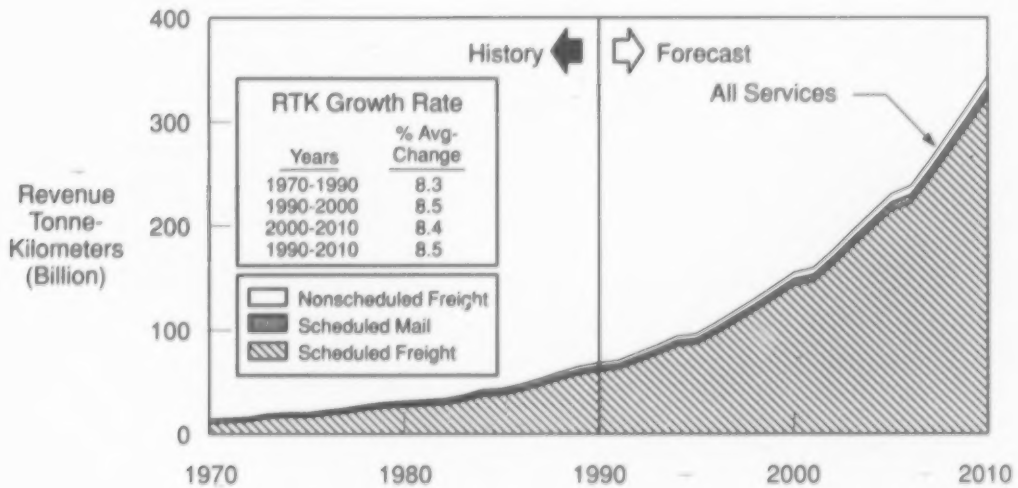
Yet the good news predominates. While the processes are slow, trade barriers within regions are gradually being reduced. The economic union in Europe (EC92), the new Commonwealth of Independent States in Eastern Europe, and the North America Free-Trade Agreement show that the economic benefits of increased trade can overcome formidable obstacles.

# *Cargo Traffic*

Air cargo growth is highly correlated with increases in world trade and GDP. Thus, total revenue tonne-kilometers will continue to show strong growth, averaging 8.5 percent per year for the next decade and 8.4 percent annually for the one following.

Air cargo is the sum of three parts: scheduled freight, mail, and nonscheduled freight. Scheduled freight is both the largest and fastest-growing component of total cargo. In 1990, scheduled freight was 88 percent of the world total of 69.1 billion RTKs. It will grow at an annual average rate of 8.6 percent through 2010, when it will have a 94-percent share of total world cargo.

## *World Cargo Traffic*




Excludes U.S.S.R.

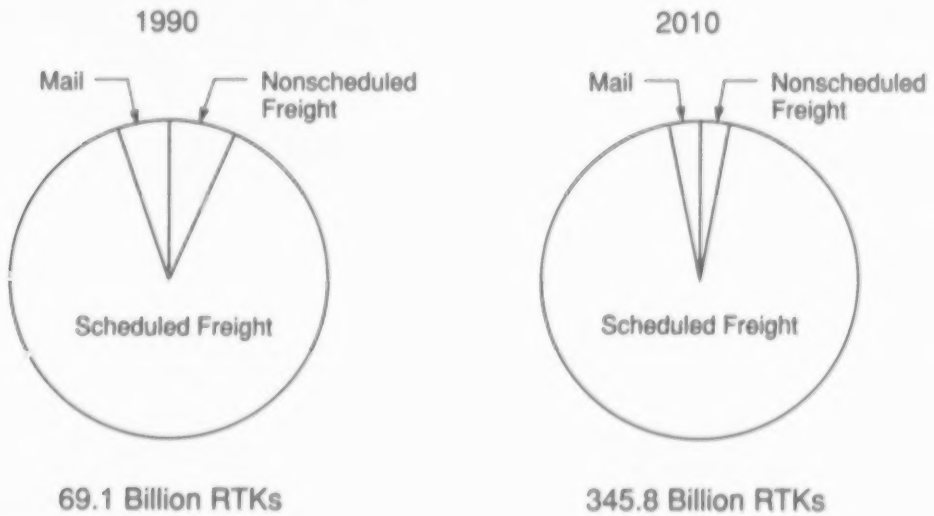
VBC0121-39

Mail commanded 6.7 percent of total cargo traffic in 1990. This service is forecast to increase at an annual average rate of 4 percent through 2010. Because mail is expected to grow moderately throughout the forecast, it is predicted to be just 3 percent of total cargo traffic by 2010.

Scheduled cargo is the sum of scheduled freight and mail. This measure comprises nearly 95 percent of total cargo. It will grow at 8.5 percent per year throughout the forecast period, just 0.1 percent a year below the rate of total cargo. Scheduled cargo is the broadest measure of RTKs available on a route-by-route basis in the forecast.

Nonscheduled freight has historically grown at about two-thirds the rate of scheduled freight. The forecast suggests that this relationship will continue: nonscheduled freight is predicted to increase at an annual average rate of 5.6 percent. In 1990, this segment was 5.3 percent of the total cargo market. By 2010, it is expected to decline to 3.2 percent of the total.

## *Composition of World Cargo Traffic*




Excludes U.S.S.R.

V8C0121-40

The high level of economic growth expected in Pacific/Asia will produce rapid increases in air cargo traffic on routes in this part of the world. Scheduled air cargo on the Intra-Far East and Pacific route is expected to grow at an annual average rate of 12.1 percent through 2010. In the same period, the North and Mid-Pacific and Europe-Far East routes will enjoy annual average growth of 11.4 percent and 8.8 percent, respectively. The cumulative impact on Pacific/Asia routes' share of world RTKs is dramatic.

The largest route for scheduled air cargo is U.S. Domestic, with a 20.5-percent share in 1990. RTKs within the U.S. are forecast to grow at 5.8 percent annually through 2010. The higher growth rates in Pacific/Asia and on the North Atlantic will cause domestic RTKs in the United States to decline to fifth place in the world by the end of the forecast period.

## *Scheduled Cargo Traffic*

### *By Major Route*

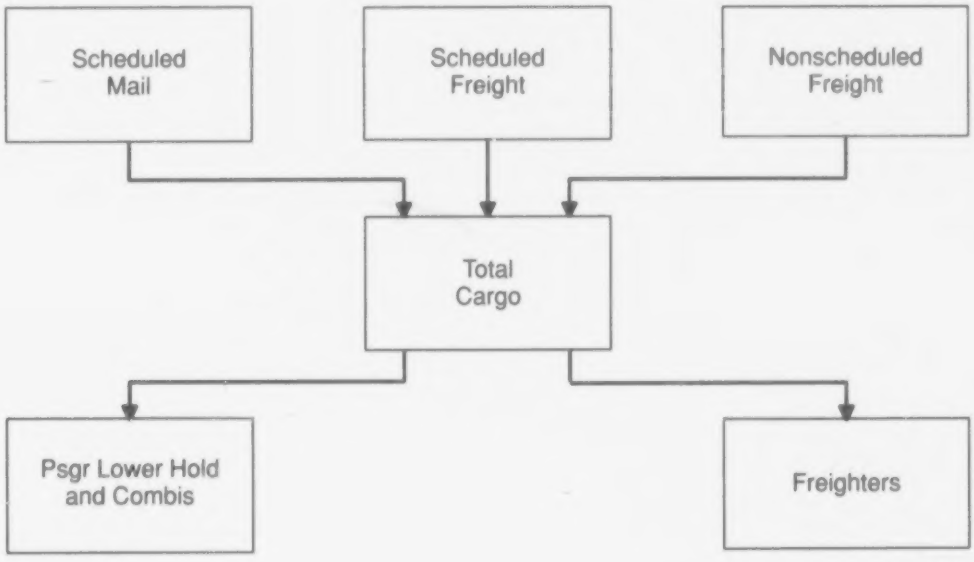
| Route | 1990-2010 Average Growth (%) | Share of World RTKs (%) | |
|---|---|---|---|
| | | 1990 | 2010 |
| U.S. Domestic | 5.8 | 20.5 | 12.4 |
| North Atlantic | 6.6 | 18.5 | 13.0 |
| North and Mid Pacific | 11.4 | 16.3 | 27.4 |
| Europe-Far East | 8.8 | 15.5 | 16.2 |
| Intra-Far East and Pacific | 12.1 | 8.1 | 15.6 |
| Europe-Africa | 7.6 | 3.7 | 3.1 |
| Intra-Europe | 4.3 | 2.0 | .9 |
| Europe-Middle East | 2.8 | 1.9 | .7 |
| North America-South America | 7.6 | 1.8 | 1.5 |
| South Atlantic | 8.6 | 1.7 | 1.7 |
| Total Major Routes | 8.7 | 90.0 | 92.5 |
| Total World* | 8.5 | 100.0 | 100.0 |

*Excludes U.S.S.R. Domestic

VBC0121-41

Once the total cargo forecast is completed, the next task is to allocate shares of this total to passenger and freighter aircraft. In the past two decades, the share of total cargo carried by freighter aircraft declined. That decrease was largely caused by the introduction of wide-body and combi aircraft — considered to be passenger planes for this purpose — and by better utilization of these aircraft. Future increases in passenger airplanes' average belly capacities and utilization are expected to be more modest. Thus, the higher growth of the cargo market relative to passenger traffic requires that dedicated freighter aircraft take a greater share of RTKs in the future.

## *Cargo Composition and Flow*




VBC0121-42

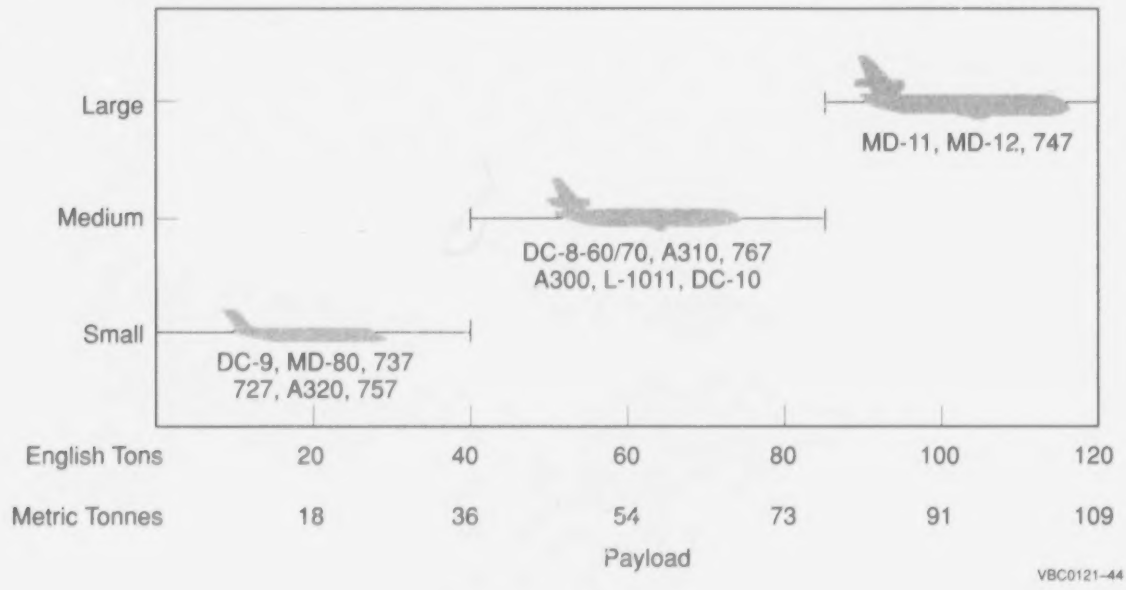
# *Freighter Capacity Assumptions*

Freighter aircraft have been grouped into three generic classes in terms of payload. Based on existing freighter models and aircraft that are good candidates to be converted to freighters by 2010, these categories are:

- Small Freighters, including the DC-9, MD-80, 737, 727, A320, and 757
- Medium Freighters, comprising the DC-8-60/70, A310, 767, A300, L-1011, and DC-10
- Large Freighters, consisting of the MD-11, MD-12, and 747

## *Freighter Aircraft Classes*

***As Defined by McDonnell Douglas***



# *Freighter Fleet Requirements*

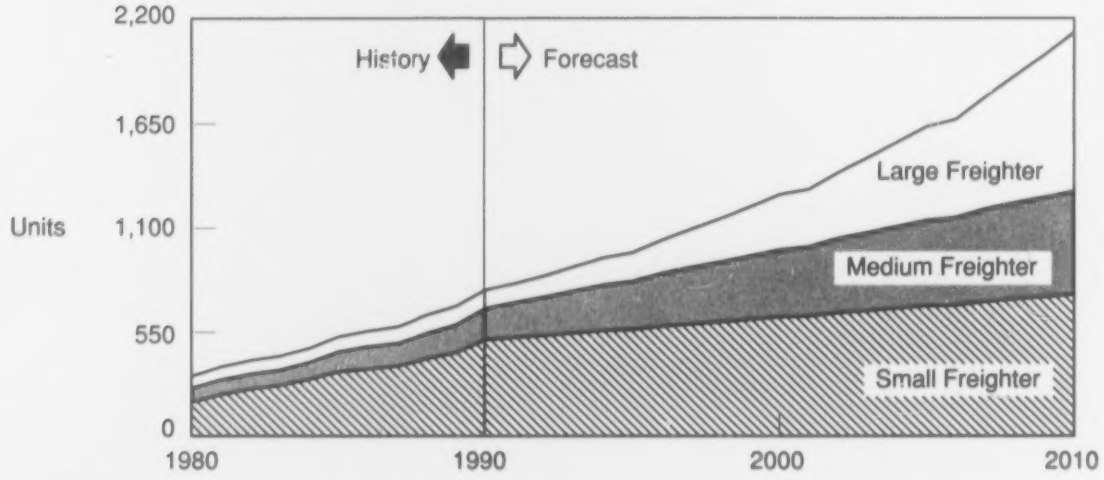
The 311 all-cargo aircraft in 1980 more than doubled to 768 such planes by 1990. The rapid growth of the small package carriers spurred tremendous growth in small-to-medium freighters in the past decade, mainly in the United States. With this domestic-feed network established, these carriers are expected to use large freighters to expand internationally. These North America-domiciled airlines will join those of Europe and Pacific/Asia that have already committed to substantial fleets of large freighters for international markets.

- By 2010, the forecast growth in air cargo will require a fleet of 839 large freighters, compared with 96 such aircraft in service in 1990, a growth rate exceeding 11 percent per year. A large part of this fleet will be devoted to serving routes involving Pacific/Asia.
- The medium freighter fleet will grow at a 6-percent average annual rate over the next 20 years, increasing from 170 to 548 planes. This equipment will be targeted for routes across the Atlantic and similar distances.
- The number of small freighters will show the slowest growth of the three generic classes, averaging 2 percent per year. This fleet will grow from 502 units in 1990 to 742 in 2010. These planes will serve mainly domestic and regional markets.

According to the forecast, the total world freighter fleet will nearly triple over the next 20 years, from 768 units in 1990 to 2,129 in 2010.

## *World Freighter Fleet*

***In Active Commercial Service***




Excludes U.S.S.R.

VBC0121-43

# *Appendix*

## WORLD PASSENGER TRAFFIC
(ALL SERVICES, IN BILLIONS OF RPKs AND ASKs)

| Year | RPKs | Annual Percent Growth Rate (RPKs) | ASKs | Annual Percent Growth Rate (ASKs) | Load Factor |
|---|---|---|---|---|---|
| 1970 | 399.7 | 19.5 | 751.7 | 17.7 | 53.2 |
| 1971 | 440.4 | 10.2 | 839.4 | 11.7 | 52.5 |
| 1972 | 503.9 | 14.4 | 905.9 | 7.9 | 55.6 |
| 1973 | 587.1 | 16.5 | 1,026.2 | 13.3 | 57.2 |
| 1974 | 630.3 | 7.4 | 1,066.7 | 4.0 | 59.1 |
| 1975 | 667.5 | 5.9 | 1,137.9 | 6.7 | 58.7 |
| 1976 | 728.8 | 9.2 | 1,219.8 | 7.2 | 59.8 |
| 1977 | 796.2 | 9.3 | 1,308.0 | 7.2 | 60.9 |
| 1978 | 906.9 | 13.9 | 1,415.8 | 8.2 | 64.1 |
| 1979 | 1,008.0 | 11.1 | 1,543.5 | 9.0 | 65.3 |
| 1980 | 1,014.0 | 0.6 | 1,622.1 | 5.1 | 62.5 |
| 1981 | 1,037.9 | 2.4 | 1,653.9 | 2.0 | 62.8 |
| 1982 | 1,067.6 | 2.9 | 1,698.8 | 2.7 | 62.8 |
| 1983 | 1,114.3 | 4.4 | 1,750.1 | 3.0 | 63.7 |
| 1984 | 1,205.5 | 8.2 | 1,878.9 | 7.4 | 64.2 |
| 1985 | 1,308.7 | 8.6 | 2,005.2 | 6.7 | 65.3 |
| 1986 | 1,393.5 | 6.5 | 2,161.9 | 7.8 | 64.5 |
| 1987 | 1,544.1 | 10.8 | 2,320.1 | 7.3 | 66.6 |
| 1988 | 1,660.9 | 7.6 | 2,484.2 | 7.1 | 66.9 |
| 1989 | 1,734.9 | 4.5 | 2,572.7 | 3.6 | 67.4 |
| 1990 | 1,843.1 | 6.2 | 2,764.7 | 7.5 | 66.7 |
| 1991 | 1,865.2 | 1.2 | 2,844.7 | 2.9 | 65.6 |
| 1992 | 2,022.1 | 8.4 | 3,061.8 | 7.6 | 66.0 |
| 1993 | 2,168.6 | 7.3 | 3,253.3 | 6.3 | 66.7 |
| 1994 | 2,327.2 | 7.3 | 3,484.3 | 7.1 | 66.8 |
| 1995 | 2,367.5 | 1.7 | 3,590.4 | 3.1 | 65.9 |
| 1996 | 2,580.7 | 9.0 | 3,847.5 | 7.2 | 67.1 |
| 1997 | 2,800.2 | 8.5 | 4,144.4 | 7.7 | 67.6 |
| 1998 | 3,014.3 | 7.7 | 4,433.8 | 7.0 | 68.0 |
| 1999 | 3,240.3 | 7.5 | 4,744.9 | 7.0 | 68.3 |
| 2000 | 3,476.0 | 7.3 | 5,066.7 | 6.8 | 68.6 |
| 2001 | 3,507.5 | 0.9 | 5,232.3 | 3.3 | 67.0 |
| 2002 | 3,821.9 | 9.0 | 5,621.0 | 7.4 | 68.0 |
| 2003 | 4,133.0 | 8.1 | 6,025.4 | 7.2 | 68.6 |
| 2004 | 4,431.6 | 7.2 | 6,421.4 | 6.6 | 69.0 |
| 2005 | 4,738.5 | 6.9 | 6,846.0 | 6.6 | 69.2 |
| 2006 | 4,807.3 | 1.5 | 7,047.8 | 3.0 | 68.2 |
| 2007 | 5,223.7 | 8.7 | 7,589.8 | 7.7 | 68.8 |
| 2008 | 5,646.2 | 8.1 | 8,142.5 | 7.3 | 69.3 |
| 2009 | 6,050.4 | 7.2 | 8,670.1 | 6.5 | 69.8 |
| 2010 | 6,473.6 | 7.0 | 9,232.1 | 6.5 | 70.1 |

## PASSENGER AIRCRAFT BY GENERIC CLASS

**SHORT RANGE-100**
(S100: 61-135 Seats)

A319*
BAC 111
BAe 146
727-100
737 (ALL SERIES EXCEPT -400)
DC-9
F-100
F28
IL-18
MD-87
MD-95*
CARAVELLE
TU-134
YAK-42

**SHORT RANGE-150**
(S150: 136-175 Seats)

A320
727-200
737-400
MERCURE
TRIDENT 2E
MD-80 (ALL SERIES EXCEPT -87)
MD-90
TU-154

**MEDIUM RANGE-200**
(M200: 176-230 Seats)

A310
A321
707
720
757
767-200
CONCORDE
DC-8 (ALL SERIES EXCEPT -62/-72)
IL-62

**LONG RANGE-200**
(L200: 176-230 Seats)

767ER
DC-8-62/-72

**MEDIUM RANGE-300**
(M300: 231-350 Seats)

A300
A330
767-300
DC-10-10/-15
L-1011 (ALL SERIES EXCEPT -500)

**LONG RANGE-300**
(L300: 231-350 Seats)

A340
747SP
777-200B
DC-10-30/-40
L-1011-500
MD-11

**MEDIUM RANGE-400**
(M400: 351-475 Seats)

747-100
777-200A/-300*
MD-12MR*

**LONG RANGE-400**
(L400: 351-475 Seats)

747-200/-300/-400
MD-12*

**MEDIUM RANGE-600**
(M600: 476-675 Seats)

747SR/D

**LONG RANGE-600**
(L600: 476-675 Seats)

PRELIMINARY DESIGN STAGE*

*Planned Models Pending Launch

Model Inclusion Reflects Typical 2-Class Seating Configurations for Short- and Medium-Range Aircraft, and Typical 3-Class Configurations for Long-Range Aircraft. Short Range is Defined as up to 3,000 Nautical Miles With Passengers and Baggage, Medium Range Between 3,000 and 5,000 Nautical Miles, and Long Range Exceeding 5,000 Nautical Miles.

# TOTAL WORLD
# PASSENGER JET AIRCRAFT REQUIREMENTS BY GENERIC CLASS

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | TTL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHORT RANGE-100 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | 180 | 153 | 156 | 112 | 110 | 125 | 98 | 105 | 99 | 96 | 63 | 63 | 75 | 81 | 66 | 75 | 72 | 85 | 81 | 144 | 2039 |
| Orders | | 176 | 166 | 164 | 133 | 63 | 15 | 11 | | | | | | | | | | | | | | 728 |
| Open Market | | 6 | 2 | 17 | 22 | 22 | 62 | 179 | 153 | 143 | 135 | 40 | 100 | 57 | 136 | 135 | 60 | 127 | 94 | 80 | 87 | 1657 |
| End-of-Year Total | 2955 | 2957 | 2972 | 2997 | 3040 | 3015 | 2967 | 3059 | 3107 | 3151 | 3190 | 3167 | 3204 | 3186 | 3241 | 3310 | 3295 | 3350 | 3359 | 3358 | 3301 | |
| SHORT RANGE-150 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | 20 | 46 | 41 | 54 | 84 | 70 | 62 | 94 | 85 | 44 | 58 | 71 | 58 | 59 | 56 | 96 | 114 | 33 | 38 | 52 | 1235 |
| Orders | | 248 | 199 | 104 | 95 | 70 | 57 | 10 | 4 | 3 | | | | | | | | | | | | 790 |
| Open Market | | | 17 | 48 | 70 | 41 | 99 | 212 | 233 | 250 | 214 | 94 | 228 | 225 | 215 | 172 | 89 | 221 | 176 | 155 | 175 | 2934 |
| End-of-Year Total | 2188 | 2416 | 2586 | 2697 | 2808 | 2835 | 2921 | 3081 | 3224 | 3392 | 3562 | 3598 | 3755 | 3922 | 4078 | 4194 | 4187 | 4294 | 4437 | 4554 | 4677 | |
| MEDIUM RANGE-200 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | 21 | 12 | 9 | 12 | 18 | 9 | 8 | 14 | 10 | 7 | 3 | 13 | 3 | 3 | 4 | 1 | 3 | 7 | 33 | 76 | 266 |
| Orders | | 96 | 84 | 54 | 47 | 51 | 34 | 20 | 15 | 7 | 6 | | | | | | | | | | | 414 |
| Open Market | | | 1 | 30 | 76 | 23 | 80 | 111 | 108 | 108 | 123 | 61 | 123 | 123 | 127 | 144 | 54 | 140 | 166 | 159 | 224 | 1981 |
| End-of-Year Total | 703 | 778 | 851 | 926 | 1037 | 1093 | 1198 | 1321 | 1430 | 1535 | 1657 | 1715 | 1825 | 1945 | 2069 | 2209 | 2262 | 2399 | 2558 | 2684 | 2832 | |
| LONG RANGE-200 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | | 4 | 7 | 3 | 6 | | | 2 | | | | 1 | 1 | | 1 | 1 | 2 | 1 | 17 | 17 | 63 |
| Orders | | 35 | 24 | 29 | 14 | 2 | 1 | | | | | | | | | | | | | | | 105 |
| Open Market | | 1 | 7 | 12 | 19 | 13 | 34 | 29 | 28 | 34 | 29 | 7 | 28 | 24 | 6 | 26 | 5 | 24 | 26 | 24 | 25 | 401 |
| End-of-Year Total | 214 | 250 | 277 | 311 | 341 | 350 | 385 | 414 | 440 | 474 | 503 | 510 | 537 | 560 | 566 | 591 | 595 | 617 | 642 | 649 | 657 | |
| MEDIUM RANGE-300 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | | | | 15 | 35 | 26 | 30 | 21 | 11 | 14 | 18 | 26 | 38 | 27 | 27 | 38 | 52 | 28 | 39 | 24 | 469 |
| Orders | | 35 | 16 | 28 | 28 | 32 | 30 | 8 | 1 | | | | | | | | | | | | | 178 |
| Open Market | | | 1 | 2 | 13 | 9 | 11 | 20 | 26 | 45 | 46 | 33 | 53 | 76 | 70 | 78 | 58 | 113 | 103 | 96 | 110 | 963 |
| End-of-Year Total | 656 | 691 | 708 | 738 | 764 | 770 | 785 | 783 | 789 | 823 | 855 | 870 | 897 | 935 | 978 | 1029 | 1049 | 1110 | 1185 | 1242 | 1328 | |
| LONG RANGE-300 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | | | | 2 | 10 | 18 | 17 | 12 | 3 | 9 | 15 | 31 | 26 | 34 | 25 | 47 | 27 | 13 | 9 | 9 | 307 |
| Orders | | 47 | 60 | 54 | 29 | 26 | 4 | | | | | | | | | | | | | | | 220 |
| Open Market | | | 2 | 6 | 13 | 21 | 34 | 34 | 48 | 48 | 51 | 39 | 67 | 66 | 74 | 66 | 41 | 75 | 67 | 55 | 53 | 860 |
| End-of-Year Total | 423 | 470 | 532 | 592 | 632 | 669 | 689 | 706 | 742 | 787 | 829 | 853 | 889 | 929 | 969 | 1010 | 1004 | 1052 | 1106 | 1152 | 1196 | |
| MEDIUM RANGE-400 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | 8 | 19 | 20 | 12 | 20 | 8 | 8 | 3 | 10 | 7 | 5 | 1 | 2 | 4 | | — | 1 | 2 | | 1 | 131 |
| Orders | | | | | 2 | 14 | 22 | 11 | | | | | | | | | | | | | | 49 |
| Open Market | | | 3 | | 2 | 3 | 8 | 31 | 27 | 27 | 41 | 27 | 49 | 58 | 56 | 57 | 31 | 60 | 77 | 68 | 81 | 706 |
| End-of-Year Total | 131 | 123 | 107 | 87 | 79 | 76 | 98 | 132 | 156 | 173 | 207 | 229 | 277 | 333 | 385 | 442 | 473 | 532 | 607 | 675 | 755 | |
| LONG RANGE-400 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | 3 | 6 | | 4 | | 7 | 3 | 12 | 9 | 9 | 9 | 22 | 12 | 13 | 9 | 15 | 20 | 13 | 12 | 25 | 203 |
| Orders | | 55 | 42 | 41 | 45 | 28 | 20 | 16 | 12 | 6 | | | | | | | | | | | | 265 |
| Open Market | | | 4 | 10 | 10 | 11 | 29 | 62 | 74 | 78 | 71 | 58 | 94 | 95 | 84 | 76 | 51 | 117 | 97 | 96 | 107 | 1226 |
| End-of-Year Total | 362 | 414 | 454 | 505 | 556 | 595 | 637 | 712 | 786 | 861 | 923 | 972 | 1044 | 1127 | 1198 | 1265 | 1301 | 1398 | 1482 | 1568 | 1650 | |
| MEDIUM RANGE-600 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | | 1 | | | | | | 2 | 3 | 8 | 4 | 2 | | | 1 | 2 | | | | | 23 |
| Orders | | 2 | | | | 3 | | | | | | | | | | | | | | | | 5 |
| Open Market | | | | | 1 | | 1 | 1 | 7 | 4 | 4 | 2 | 2 | 3 | 3 | 8 | 5 | 16 | 27 | 26 | 20 | 130 |
| End-of-Year Total | 28 | 30 | 29 | 29 | 30 | 33 | 34 | 35 | 40 | 41 | 37 | 35 | 35 | 38 | 41 | 48 | 51 | 67 | 94 | 120 | 140 | |
| LONG RANGE-600 | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | | | | | | | | | | | | | | | | | | | | | 0 |
| Orders | | | | | | | | | | | | | | | | | | | | | | 0 |
| Open Market | | | | | | | | | | | 5 | 11 | 21 | 28 | 31 | 37 | 30 | 55 | 59 | 65 | 68 | 410 |
| End-of-Year Total | | | | | | | | | | | 5 | 16 | 37 | 65 | 96 | 133 | 163 | 218 | 277 | 342 | 410 | |
| TOTAL | | | | | | | | | | | | | | | | | | | | | | |
| Perm Retired | | 232 | 241 | 233 | 214 | 283 | 263 | 226 | 265 | 230 | 194 | 175 | 230 | 215 | 221 | 189 | 275 | 291 | 182 | 229 | 348 | 4736 |
| Orders | | 694 | 591 | 474 | 393 | 299 | 183 | 76 | 32 | 16 | 6 | | | | | | | | | | | 2754 |
| Open Market | | 7 | 37 | 125 | 226 | 143 | 358 | 679 | 704 | 737 | 719 | 372 | 765 | 756 | 802 | 799 | 424 | 948 | 692 | 826 | 950 | 11268 |
| End-of-Year Total | 7660 | 8129 | 8516 | 8882 | 9287 | 9436 | 9714 | 10243 | 10714 | 11237 | 11768 | 11965 | 12500 | 13040 | 13621 | 14231 | 14380 | 15037 | 15747 | 16344 | 16946 | |

Orders placed through April 30, 1991 for deliveries beginning January 1, 1991. Excludes unassigned leasing company orders.

## WORLD CARGO TRAFFIC
(ALL SERVICES, RTKs IN BILLIONS)

| Year | Scheduled Cargo | NonScheduled Freight | Total Cargo | Growth Rate (%) |
|---|---|---|---|---|
| 1970 | 12.8 | 1.2 | 14.0 | 11.5 |
| 1971 | 13.8 | 1.2 | 15.0 | 7.0 |
| 1972 | 15.5 | 1.3 | 16.8 | 11.7 |
| 1973 | 17.7 | 1.5 | 19.2 | 14.8 |
| 1974 | 19.1 | 1.6 | 20.7 | 7.5 |
| 1975 | 19.3 | 1.6 | 20.9 | 1.0 |
| 1976 | 21.4 | 1.7 | 23.1 | 10.6 |
| 1977 | 23.5 | 1.8 | 25.3 | 9.4 |
| 1978 | 25.9 | 1.9 | 27.8 | 9.9 |
| 1979 | 28.0 | 2.0 | 30.0 | 8.0 |
| 1980 | 29.4 | 2.1 | 31.5 | 5.2 |
| 1981 | 31.0 | 2.2 | 33.2 | 5.3 |
| 1982 | 31.6 | 2.2 | 33.8 | 1.9 |
| 1983 | 35.5 | 2.4 | 37.9 | 11.9 |
| 1984 | 40.7 | 2.6 | 43.3 | 14.3 |
| 1985 | 41.3 | 2.7 | 44.0 | 1.8 |
| 1986 | 45.2 | 2.8 | 48.0 | 9.0 |
| 1987 | 50.7 | 3.0 | 53.7 | 11.8 |
| 1988 | 56.5 | 3.3 | 59.8 | 11.4 |
| 1989 | 61.7 | 3.5 | 65.2 | 9.1 |
| 1990 | 65.4 | 3.7 | 69.1 | 6.0 |
| 1991 | 67.8 | 3.8 | 71.6 | 3.6 |
| 1992 | 74.8 | 4.1 | 78.9 | 10.2 |
| 1993 | 81.9 | 4.4 | 86.3 | 9.3 |
| 1994 | 89.4 | 4.5 | 93.9 | 8.9 |
| 1995 | 92.3 | 4.7 | 97.0 | 3.3 |
| 1996 | 102.3 | 5.1 | 107.4 | 10.8 |
| 1997 | 113.5 | 5.4 | 118.9 | 10.7 |
| 1998 | 124.8 | 5.7 | 130.5 | 9.8 |
| 1999 | 136.7 | 5.9 | 142.6 | 9.3 |
| 2000 | 149.6 | 6.3 | 155.9 | 9.4 |
| 2001 | 153.4 | 6.6 | 160.0 | 2.6 |
| 2002 | 169.9 | 7.1 | 177.0 | 10.7 |
| 2003 | 187.8 | 7.5 | 195.3 | 10.3 |
| 2004 | 205.1 | 7.9 | 213.0 | 9.1 |
| 2005 | 223.0 | 8.2 | 231.2 | 8.5 |
| 2006 | 229.9 | 8.6 | 238.5 | 3.2 |
| 2007 | 254.7 | 9.2 | 263.9 | 10.6 |
| 2008 | 281.0 | 9.8 | 290.8 | 10.2 |
| 2009 | 307.3 | 10.4 | 317.7 | 9.2 |
| 2010 | 334.8 | 11.0 | 345.8 | 8.9 |

## TOTAL WORLD
## FREIGHTER JET AIRCRAFT REQUIREMENTS BY GENERIC CLASS

| | 1990 | '91 | '92 | '93 | '94 | '95 | '96 | '97 | '98 | '99 | 2000 | '01 | '02 | '03 | '04 | '05 | '06 | '07 | '08 | '09 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SMALL | 502 | 514 | 525 | 538 | 551 | 556 | 574 | 586 | 597 | 610 | 623 | 628 | 645 | 657 | 670 | 682 | 686 | 706 | 719 | 730 | 742 |
| MEDIUM | 170 | 189 | 207 | 227 | 245 | 260 | 284 | 304 | 322 | 341 | 360 | 372 | 399 | 417 | 436 | 456 | 468 | 493 | 512 | 530 | 548 |
| LARGE | 96 | 98 | 110 | 126 | 142 | 150 | 174 | 200 | 227 | 257 | 290 | 301 | 346 | 394 | 444 | 494 | 517 | 591 | 670 | 751 | 839 |
| TOTAL | 768 | 801 | 842 | 891 | 938 | 966 | 1032 | 1090 | 1146 | 1208 | 1273 | 1301 | 1390 | 1468 | 1550 | 1632 | 1671 | 1790 | 1901 | 2011 | 2129 |

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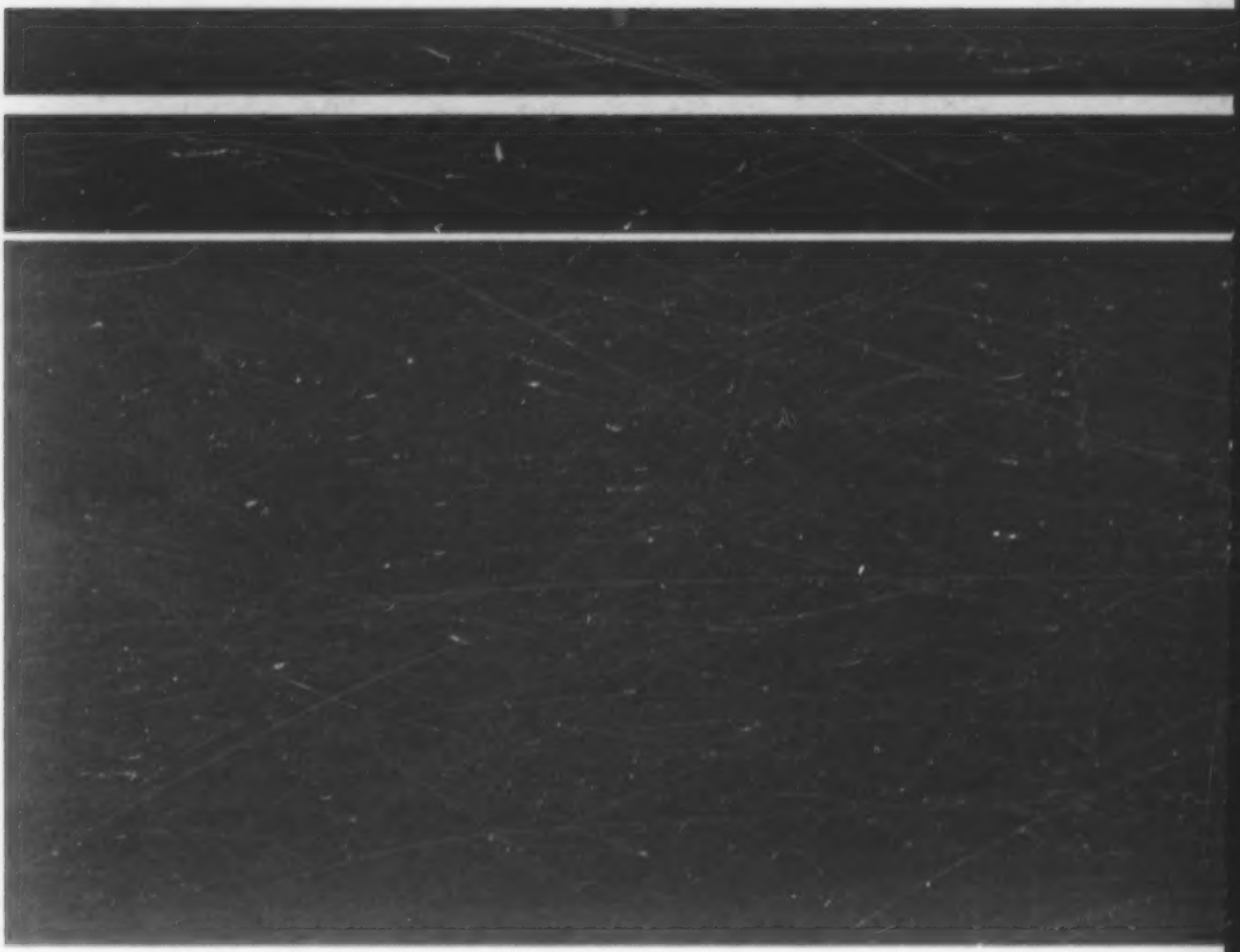

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